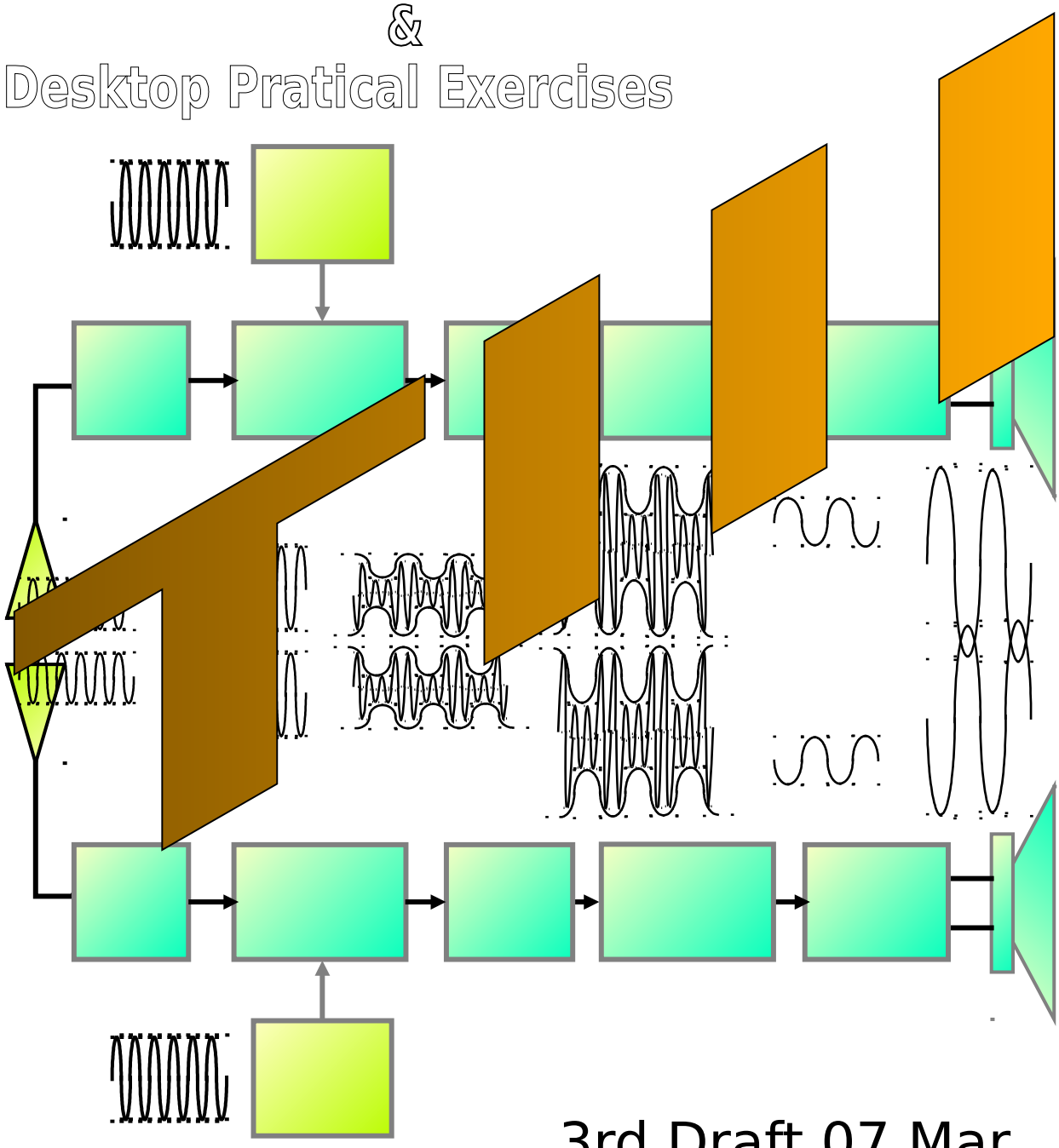
UNITED STATES ARMY OMEMS

Redstone Arsenal,AL.

Student Lesson Guide

&

Desktop Pratical Exercises



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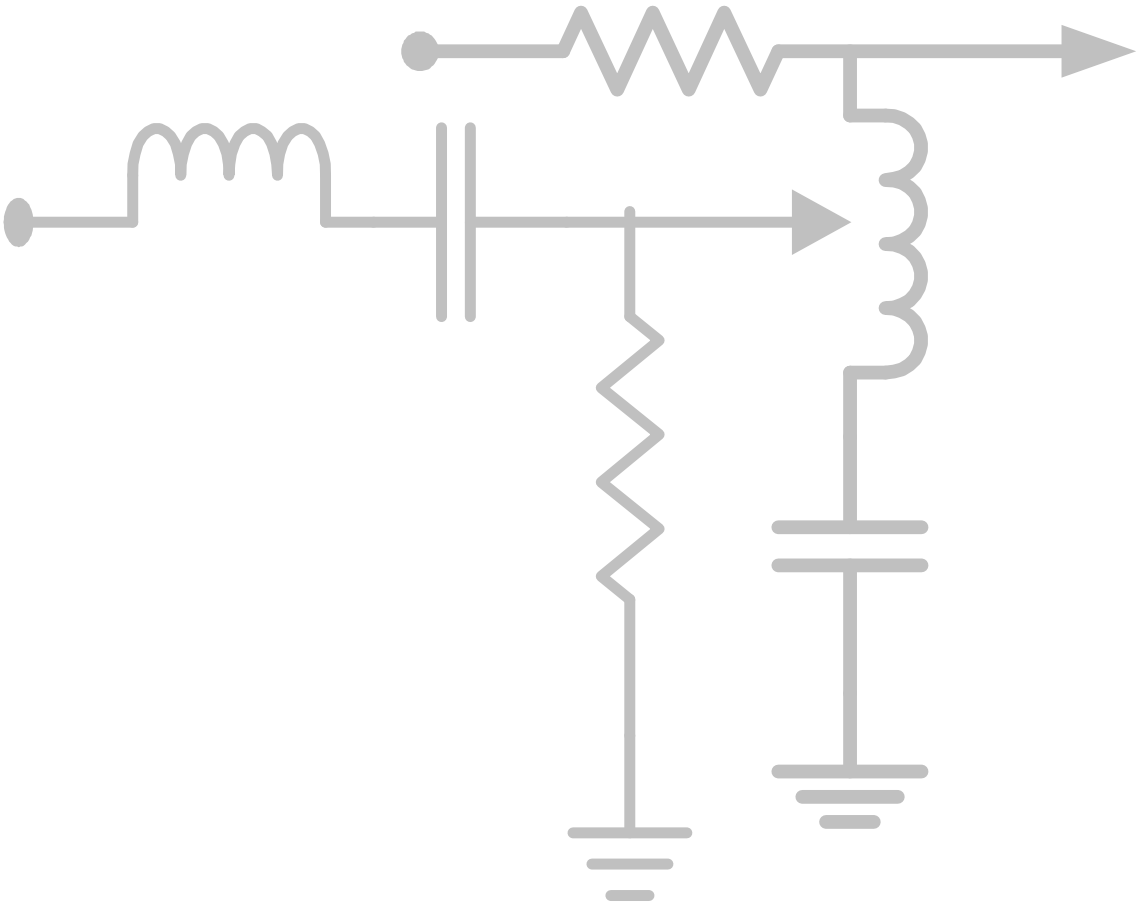
TIII:

Series Resonant Circuits

Unclassified

3 Hour Conference, W/ 3Hr PE1

Safety & Environmental Impact is “LOW”



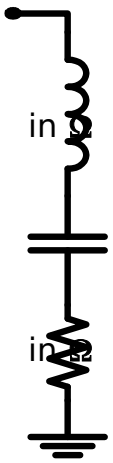
TIII: SERIES RESONANT CIRCUITS

Terms & Formulas; Reference, White Gov Tng Aid.

1. **The Frequency were the XL = XC is called <u>Resonance</u>.**
2. **Opposition [Z] to Current Flow is Minimum.**
3. **Current** Flow is **Maximum.**
4. **@ Resonance the LC <u>acts</u> like a <u>short</u>.**
5. **Above Resonance** the Ckt behaves Inductive**.**
6. **Below Resonance** the Ckt behaves Capacitive**.**
7. **RESONANCE; 1/ $2\pi\sqrt{LC}$, L X C = $\sqrt{X}$ ⇒ X 6.28 = 1/X ⇒ FR**
8. **BANDWIDTH; BW = f2 – f1**
9. **½ POWER POINT; PK Voltage X .707**
10. **QUALITY; Q = F_R/BW**
11. **<u>BANDPASS</u>;** Output across the Resistor, LC act like a Short. Passes all, from f1 to f2 inclusive of Resonant Frequency.
12. **<u>BANDREJECT</u>;** Output across the LC, Shorts Signal to Gnd.Rejects all, from f1 to f2 inclusive of Resonant Frequency.

Reactance;

Finding Reactance; X



Inductive Reactance; X_L **2π FL = X_L**

6.28 X Freq X Inductor = X_L

Capacitive Reactance; X_C **$1/2\pi$ FC = X_C**

6.28 X Freq X Cap 1/X = X_C

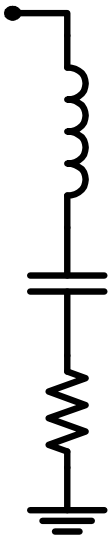
Impedance; Z $\sqrt{\ R^2 + [\ X_L - X_C\ ]^2}$

$X_L - X_C = X^2 + R$ $X^2 = \sqrt{\ } X = Z$ in Ω

TIII: SERIES RESONANT CIRCUITS

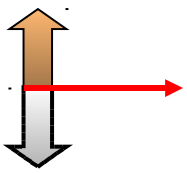
Reactance & Frequency;

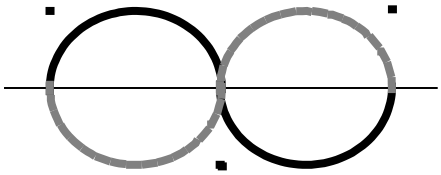
Relationship;



Inductive Reactance [X_L]; Freq ⇑, X_L ⇑ in Ω, E_L ⇑

Capacitive Reactance [X_C]; Freq ⇑ , X_C ⇓ in Ω, E_C ⇓

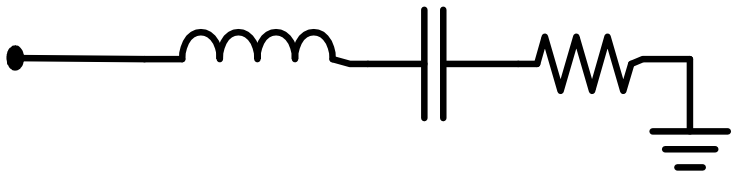




When the E_L & E_C are <u>equal</u> they will cancel each other out. The LC portion will "act" like a Short.

That Frequency is called the <u>Resonance Frequency</u>.

Resonance; Determined by the Value of the Inductor & Cap.



L = 23 mh C = .09 μf

$$F_R = \frac{1}{2\pi \sqrt{L \times C}}$$

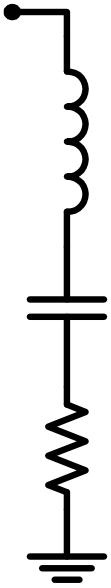
23 EE -3 X .09 EE -6 = √ X ⇒ X 6.28 = 1/X 2nd 6 ⇒ 3.499 KHz

Note:

White Gov Tng Aid. Back, panel; F

TIII: SERIES RESONANT CIRCUITS

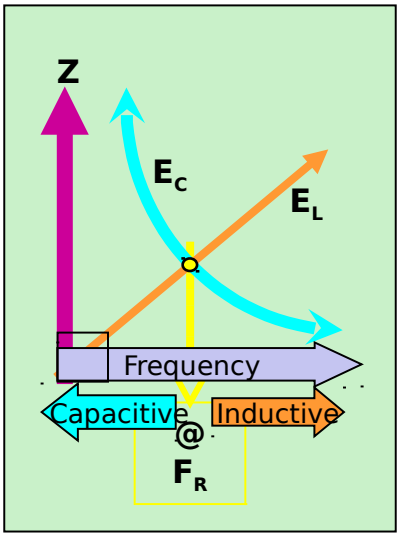
Resonance; Calculate the Resonant Frequency F_R



A.	B.	C.
L = 2 mh	L = 10 mh	L = 50 h
C = .05 μf	C = .05 μf	C = .03 μf
F_R = ____	F_R = ____	F_R = ____

$L \times C = \sqrt{X} \Rightarrow X\ 6.28 = 1/X\ 2^{nd}\ 6 \Rightarrow F_R$

Chart; Voltage current Relationship.



↓ F_R	@ F_R	↑ F_R
XC > XL EC > EL	XL = XC EL = EC	XL > XC EL > EC
I ↓ Z ↑	I is Max Z is Min	I ↓ Z ↑
Capacitive	Resistive	Inductive

Ref; White Tng Aid, Panel F

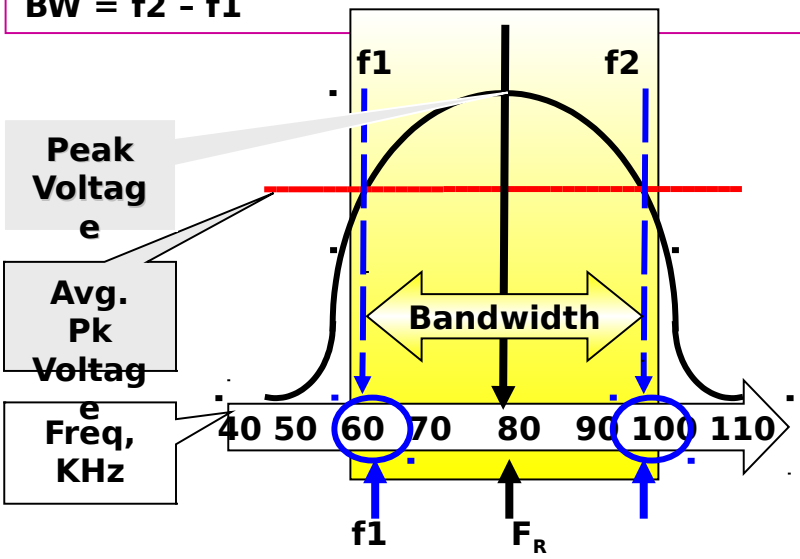
TIII: SERIES RESONANT CIRCUITS

Ref; White Tng Aid, Panel **G**

Bandwidth;

Bandwidth describes those frequencies that a tuned Ckt, dependant on the Value of the reactive devices, is responsive to and will display the average Pk Voltage amplitude on the output between f1 & f2 frequencies.

BW = f2 – f1



f2 – f1 = BW

100 - 60 = 40 KHz

The BW frequencies is 60 to 100 KHz

The Avg. Pk Voltage is Known as the ½ Power Point

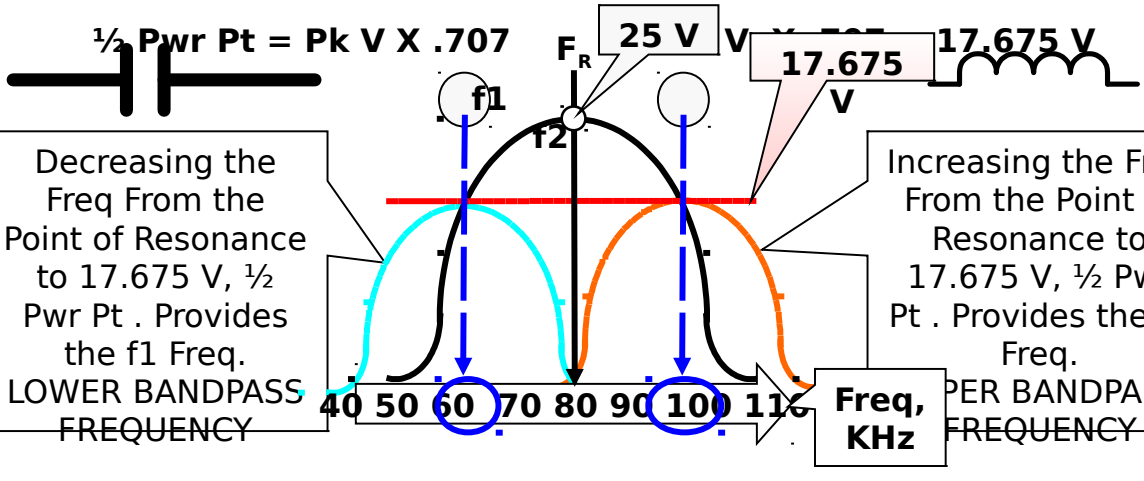
½ Power Point;

½ Power Point describes the Avg. Pk voltage of the BW.

f1 Frequency; As the Freq is ↓ signal V ↓ to 70.7% of the Pk V.

f2 Frequency; As the Freq is ↑ signal V ↓ to 70.7% of the Pk V.

½ Pwr Pt = Pk V X .707

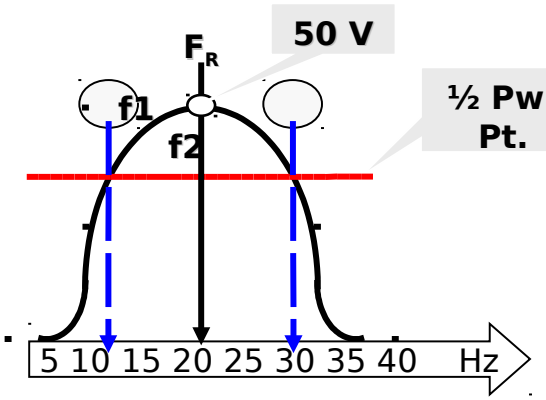


Decreasing the Freq From the Point of Resonance to 17.675 V, ½ Pwr Pt . Provides the f1 Freq. LOWER BANDPASS FREQUENCY

Increasing the Freq From the Point of Resonance to 17.675 V, ½ Pwr Pt . Provides the f2 Freq. UPPER BANDPASS FREQUENCY

TIII: SERIES RESONANT CIRCUITS

Determine the following Ckt Parameters.



F_R = _____

½ Pwr Pt = _____

f1 = _____

f2 = _____

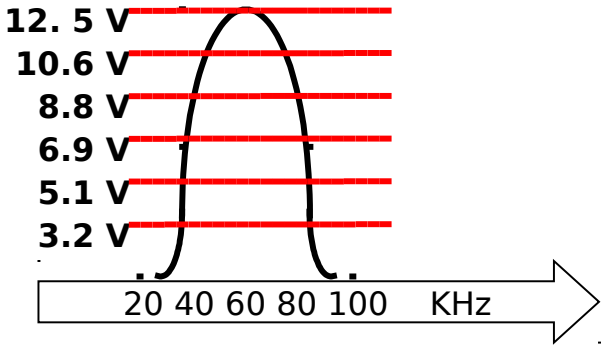
BW = _____

Q = _____

Q Describes the selectivity of the Ckt. A High Q, a Increased Selectivity. A Low Q, a Decreased Selectivity. Sometimes referred to as the Quality of the Ckt.

$$Q = \frac{FR}{BW}$$

Determine the following Ckt Parameters.



EF_R = _____

F_R = _____

½ Pwr Pt = _____

f1 = _____

f2 = _____

BW = _____

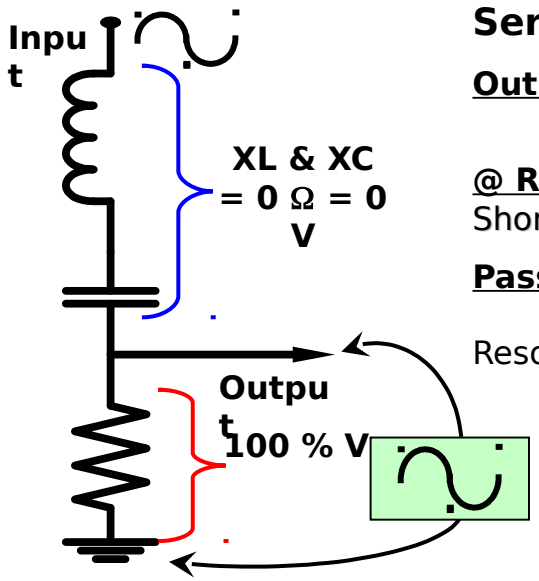
Q = _____

Ref; White Tng Aid, Panel G

TIII: SERIES RESONANT CIRCUITS

Ref; White Tng Aid, Top Left Panel **E**

Series Band Pass Filter;

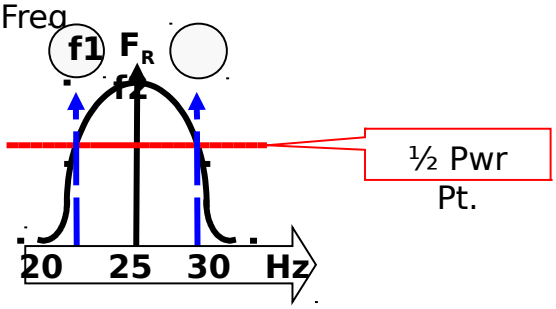


Series Band Pass Filter;

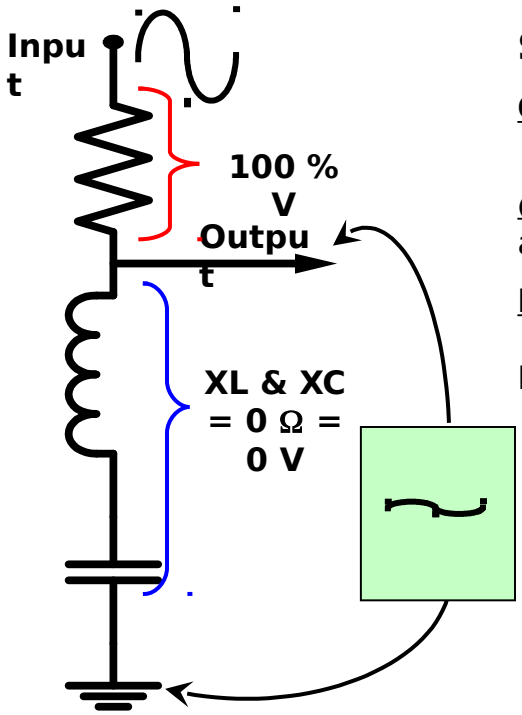
Output; Taken across the resistor, in ref. to Gnd.

@ Resonance; The LC portion acts like a Short.

Passes; All Frequencies from f1 to f2 inclusive of the Resonance Freq.



Series Band Reject Filter;

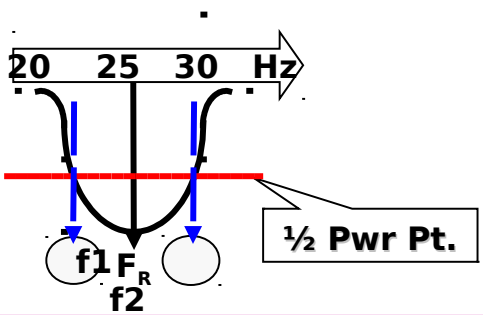


Series Band Reject Filter;

Output; Taken across the LC, in ref. to Gnd.

@ Resonance; The LC portion acts like a Short.

Rejects; All Frequencies from f1 to f2 inclusive of the Resonance Freq.



TIII: SERIES RESONANT CIRCUITS

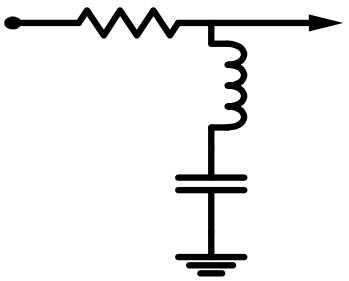
Problem Sheets; 10 Problems

1. Calculate Resonance Frequency for each of the following LC values.

a. C = .005 μf	L = 200 mh	F_R = _____
b. C = .02 μf	L = 600 mh	F_R = _____
c. C = .04 μf	L = 400 mh	F_R = _____
d. C = .001 μf	L = 20 mh	F_R = _____
e. C = .09 μf	L = 10 mh	F_R = _____

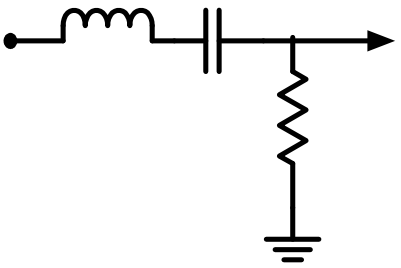
2. What type of Filter is illustrated?

_____



3. What type of Filter is illustrated?

_____



4. Below the FR a series LCR filter Acts _____ .
5. Above the FR a series LCR filter Acts _____ .
6. @ FR Current is _____ in an LCR Ckt.
7. @ FR Impedance is _____ in an LCR Ckt.

TIII: SERIES RESONANT CIRCUITS

Problem Sheets; 10 Problems

8. Note; For Question 8-10 calculate the operating parameters using the associated illustration and the ½ Pwr point for the f1 & f2 frequency's.

a. F_R _____

b. 1/2 Pwr Pt V _____

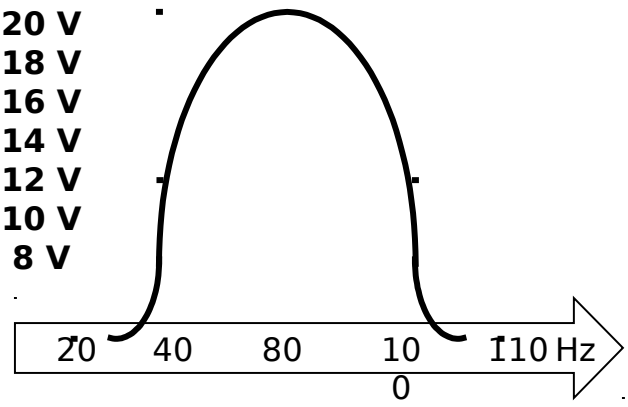
c. f2 _____

d. f1 _____

e. BW _____

f. BW Frequencies _____

g. Q _____



9.

a. F_R _____

b. 1/2 Pwr Pt V _____

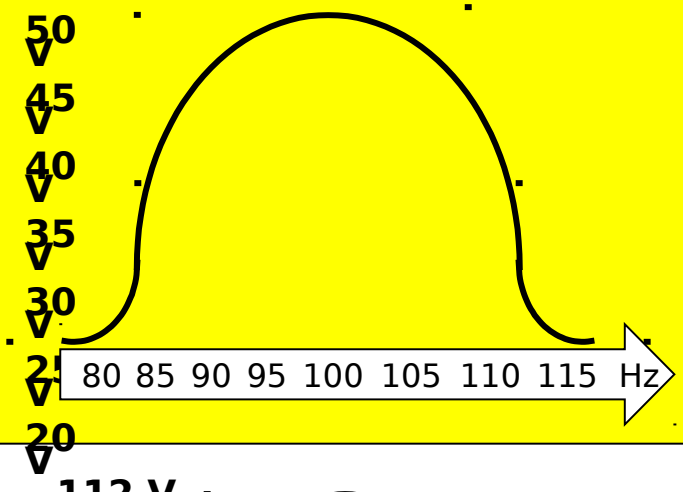
c. f2 _____

d. f1 _____

e. BW _____

f. BW Frequencies _____

g. Q _____



10.

a. F_R _____

b. 1/2 Pwr Pt V _____

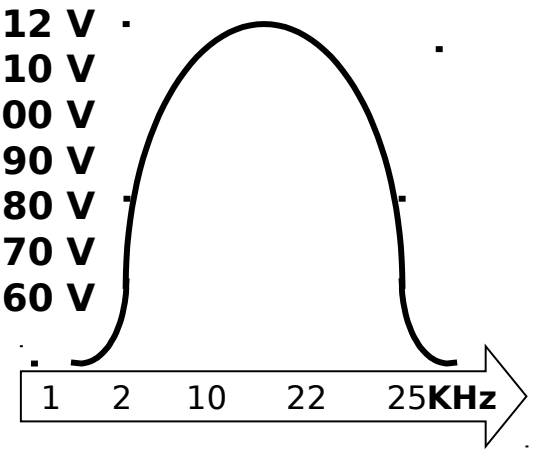
c. f2 _____

d. f1 _____

e. BW _____

f. BW Frequencies _____

g. Q ____



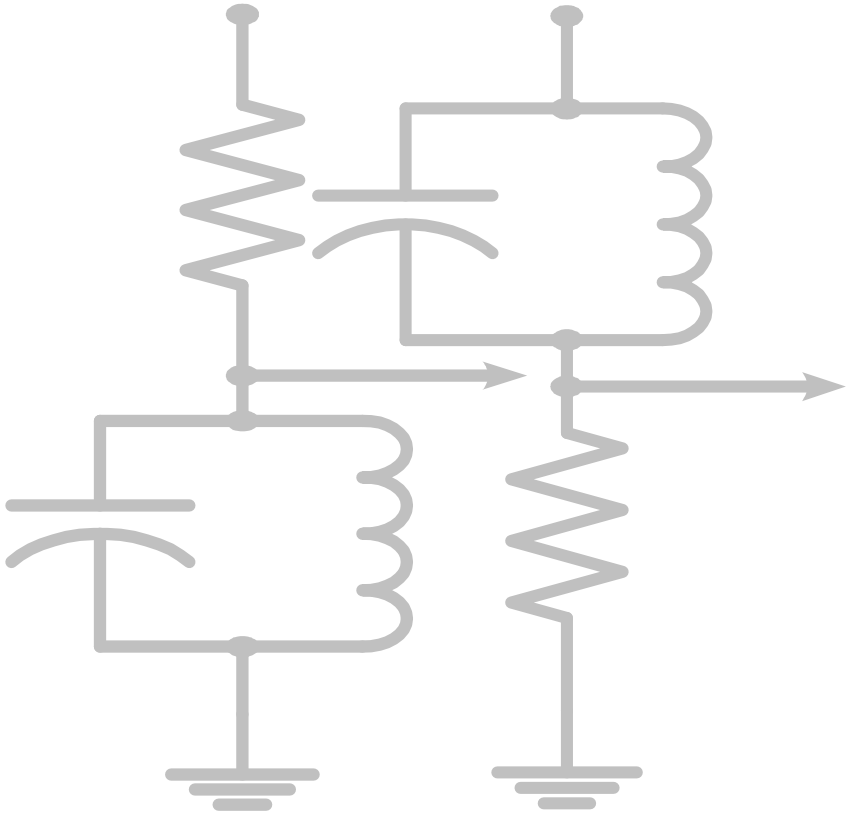
TIII:

Parallel Resonant Circuits

Unclassified

1 Hour Conference, W/ 2Hr PE1

Safety & Environmental Impact is "LOW"



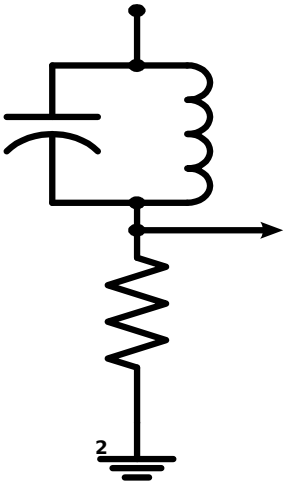
TIII: PARALLEL RESONANT CIRCUITS

Terms & Formulas; Reference, White Gov Tng Aid.

1. **The Frequency were the XL = XC is called <u>Resonance</u>.**
2. **Opposition [Z] to Current Flow is Maximum.**
3. **Current Flow is Minimum.**
4. **@ Resonance the LC (Tank) <u>acts</u> like an <u>open</u>.**
5. **Above Resonance** the Ckt behaves Capacitive**.**
6. **Below Resonance** the Ckt behaves Inductive**.**
7. **RESONANCE; 1/ $2\pi\sqrt{LC}$, L X C = $\sqrt{X} \Rightarrow$ X 6.28 = 1/X $\Rightarrow$ FR**
8. **BANDWIDTH; BW = f2 – f1**
9. **½ POWER POINT; PK Voltage X .707**
10. **QUALITY; Q = F_R/BW**
11. **<u>BAND PASS</u>;** Output across the Parallel LC Tank, LC acts like an Open. Passes all, from f1 to f2 inclusive of Resonant Frequency.
12. **<u>BAND REJECT</u>;** Output across the Resistor, Shorts Signal to Gnd. Rejects all, from f1 to f2 inclusive of Resonant Frequency.

Reactance;

Finding Reactance; X



Inductive Reactance; X_L **2π FL = X_L**

6.28 X Freq X Inductor = X_L in Ω

Capacitive Reactance; X_C **1/2π FC = X_C**

6.28 X Freq X Cap 1/X = X_C in Ω

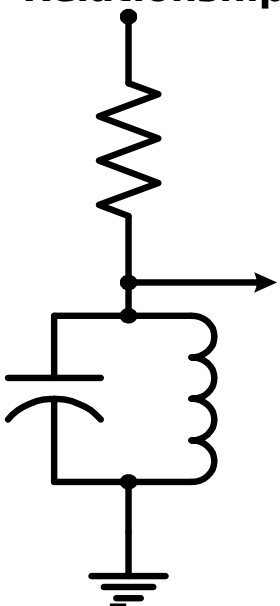
Impedance; Z $\sqrt{R^2 + [X_L - X_C]}$

$X_L - X_C = X^2 + R$ $X^2 = \sqrt{X} = Z$ in Ω

TIII: PARALLEL RESONANT CIRCUITS

Reactance & Frequency;

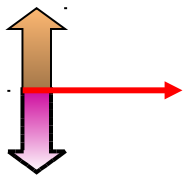
Relationship;

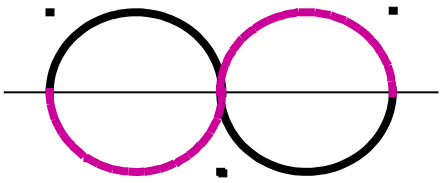


Frequency.

Inductive Reactance [X_L]; Freq ↑ , X_L ↑ in Ω, E_L ↑

Capacitive Reactance [X_C]; Freq ↑ , X_C ↓ in Ω, E_C ↓



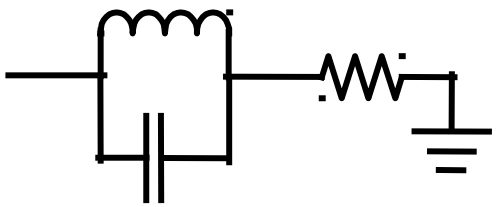


When the E_L & E_C are <u>equal</u> they will cancel each other out. The LC Tank will "act" like an Open.

That Frequency is called the <u>Resonance</u>

Resonance; Determined by the Value of the Inductor & Cap.

L = 23 m h



C = .09 μf

$$\frac{1}{2\pi\sqrt{L X_C}} = F_R$$

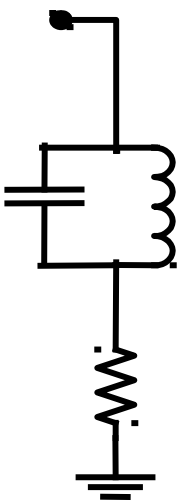
23 EE $^{-3}$ X .09 EE $^{-6}$ = √ X ⇒ X 6.28 = 1/X 2nd 6 ⇒ 3.499 KHz

Note:

White Gov Tng Aid. Back, panel; F

TIII: PARALLEL RESONANT CIRCUITS

Resonance; Calculate the Resonant Frequency F_R

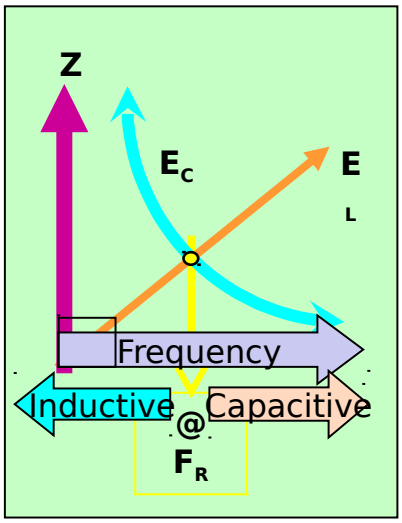


A.	B.	C.
L = 2 mh	L = 10 mh	L = 50 h
C = .05 μf	C = .05 μf	C = .03 μf
F_R = ____	F_R = ____	F_R = ____

$L \times C = \sqrt{X} \Rightarrow X \; 6.28 = 1/X \; 2^{nd} \; 6 \Rightarrow F_R$

Chart; Voltage Current Relationship.

Ref; White Tng Aid, Panel F



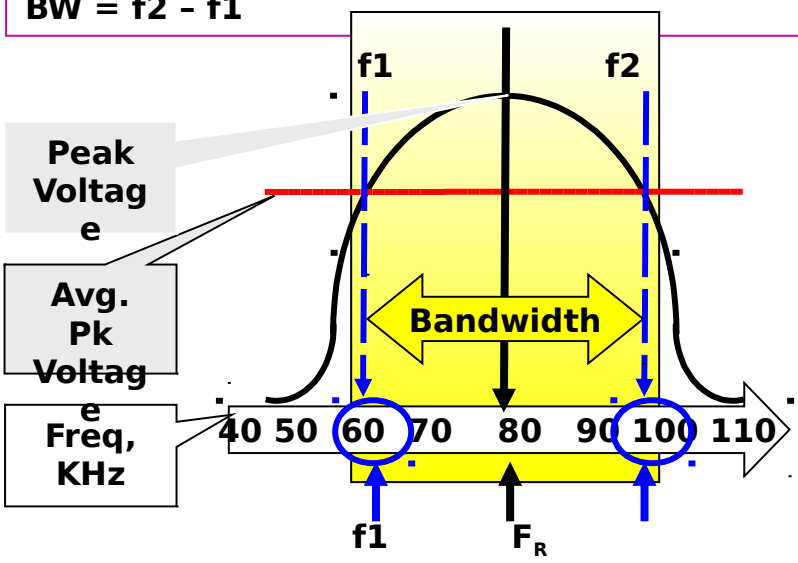
↓ F_R	@ F_R	↑ F_R
XC > XL EC > EL	XL = XC EL = EC	XL > XC EL > EC
I ↑ Z ↓	I is Min Z is Max	I ↑ Z ↓
Inductive	Resistive	Capacitive

TIII: PARALLEL RESONANT CIRCUITS

Ref; White Tng Aid, Panel **G** — Bandwidth;

Bandwidth describes those frequencies that a tuned Ckt, dependant on the Value of the reactive devices, is responsive to and will display the average Pk Voltage amplitude on the output between f1 & f2 frequencies.

BW = f2 – f1



f2 – f1 = BW

100 - 60 = 40 KHz

The BW frequencies is 60 to 100 KHz

The Avg. Pk Voltage is Known as the ½ Power Point

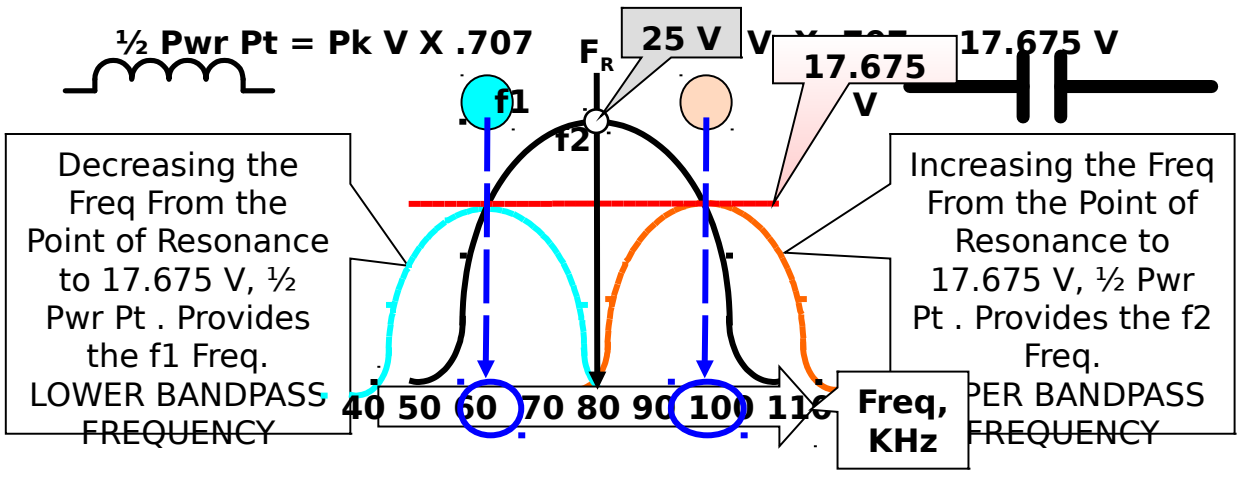
½ Power Point;

½ Power Point describes the Avg. Pk voltage of the BW.

f1 Frequency; As the Freq is ↓ signal V ↓ to 70.7% of the Pk V.

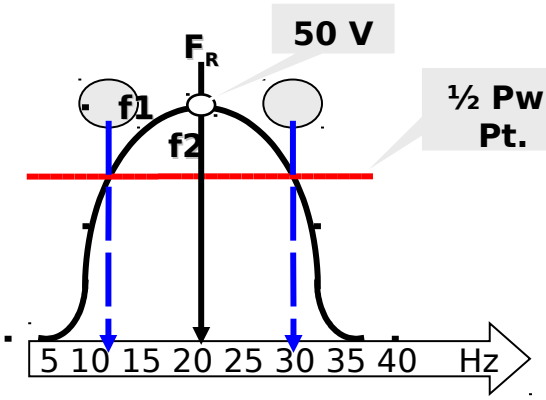
f2 Frequency; As the Freq is ↑ signal V ↓ to 70.7% of the Pk V.

½ Pwr Pt = Pk V X .707


F_R
25 V
17.675 V
f1
f2
Decreasing the Freq From the Point of Resonance to 17.675 V, ½ Pwr Pt . Provides the f1 Freq. LOWER BANDPASS FREQUENCY
Increasing the Freq From the Point of Resonance to 17.675 V, ½ Pwr Pt . Provides the f2 Freq.
PER BANDPASS FREQUENCY
40 50 60 70 80 90 100 11
Freq, KHz

TIII: PARALLEL RESONANT CIRCUITS

Determine the following Ckt Parameters.



F_R = _____

½ Pwr Pt = _____

f1 = _____

f2 = _____

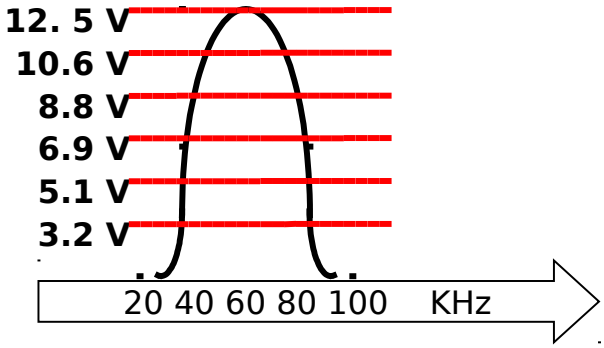
BW = _____

Q = _____

Q Describes the selectivity of the Ckt. A High Q, a Increased Selectivity. A Low Q, a Decreased Selectivity. Sometimes referred to as the Quality of the Ckt.

$$Q = \frac{FR}{BW}$$

Determine the following Ckt Parameters.



EF_R = _____

F_R = _____

½ Pwr Pt = _____

f1 = _____

f2 = _____

BW = _____

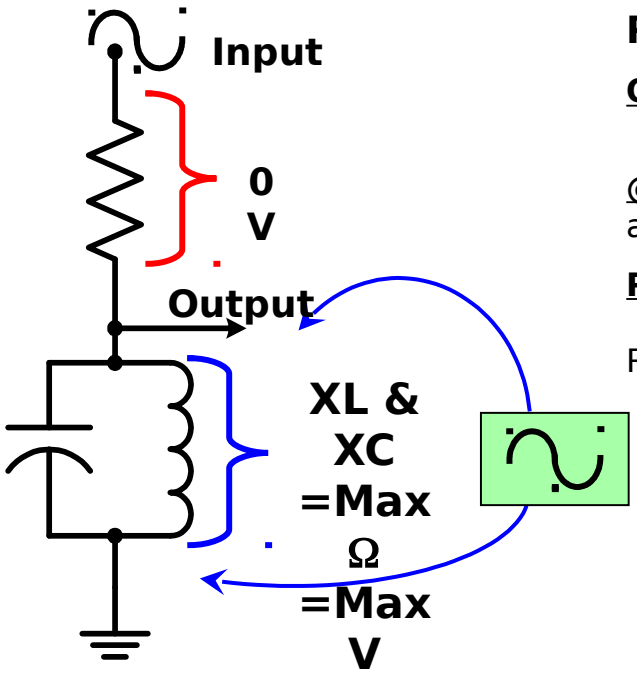
Q = _____

Ref; White Tng Aid, Panel G

TIII: PARALLEL RESONANT CIRCUITS

Ref; White Tng Aid, Top Left Panel **E**

Parallel Band Pass Filter;

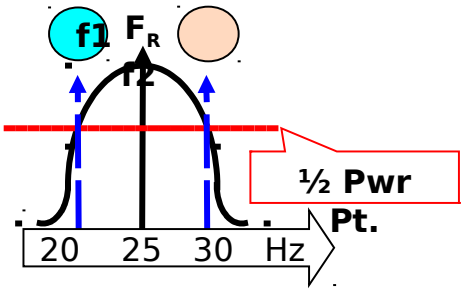


Parallel <u>Band Pass</u> Filter;

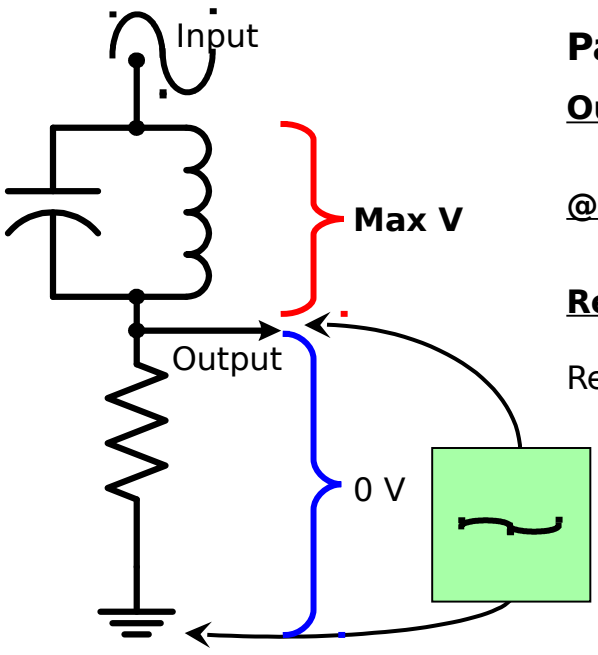
<u>Output</u>; Taken across the LC Tank, in ref. to Gnd.

<u>@ Resonance</u>; The LC Tank portion acts like an Open.

<u>Passes</u>; All Frequencies from f1 to f2 inclusive of the Resonance Freq.



Parallel Band Reject Filter;

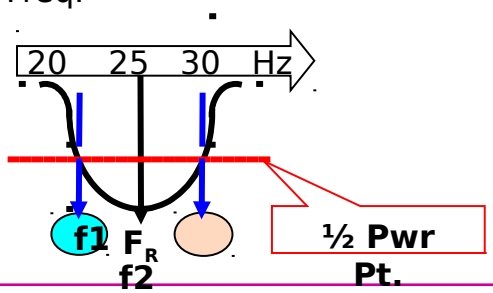


Parallel <u>Band Reject</u> Filter;

<u>Output</u>; Taken across the Resistor, in ref. to Gnd.

<u>@ Resonance</u>; The LC portion acts like a Open.

<u>Rejects</u>; All Frequencies from f1 to f2 inclusive of the Resonance Freq.



TIII: PARALLEL RESONANT CIRCUITS

Problem Sheets; 10 Problems

1. **Calculate Resonance Frequency for each of the following LC values.**

   a. C = .005 μf L = 200 mh F_R = _____

   b. C = .02 μf L = 600 mh F_R = _____

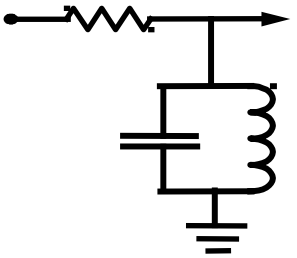
   c. C = .04 μf L = 400 mh F_R = _____

   d. C = .001 μf L = 20 mh F_R = _____

   e. C = .09 μf L = 10 mh F_R = _____

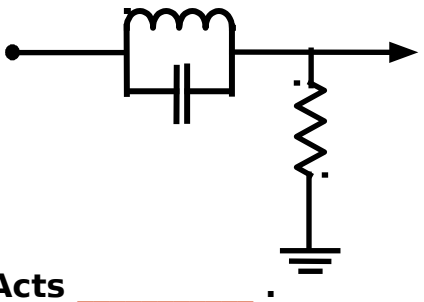
2. **What type of Filter is illustrated?**

   _____



3. **What type of Filter is illustrated?**

   _____



4. **Below the FR a parallel LCR filter Acts _____ .**
5. **Above the FR a parallel LCR filter Acts _____ .**
6. **@ FR Current is _____ in an LCR Ckt.**
7. **@ FR Impedance is _____ in an LCR Ckt.**

TIII: PARALLEL RESONANT CIRCUITS

Problem Sheets; 10 Problems

8. Note; For Question 8-10 calculate the operating parameters using the associated illustration and the ½ Pwr point for the f1 & f2 frequency's.

a. F_R _____

b. 1/2 Pwr Pt V _____

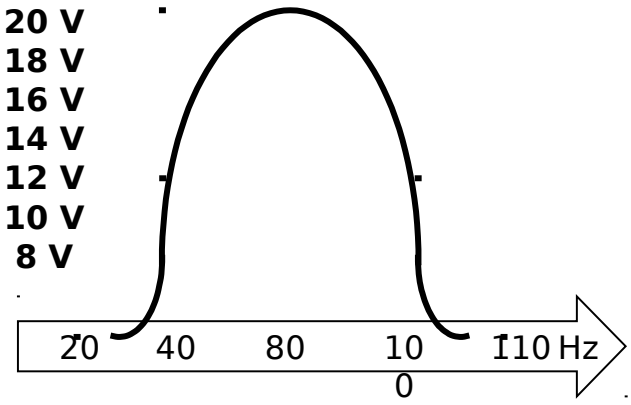
c. f2 _____

d. f1 _____

e. BW _____

f. BW Frequencies _____

g. Q _____



9.

a. F_R _____

b. 1/2 Pwr Pt V _____

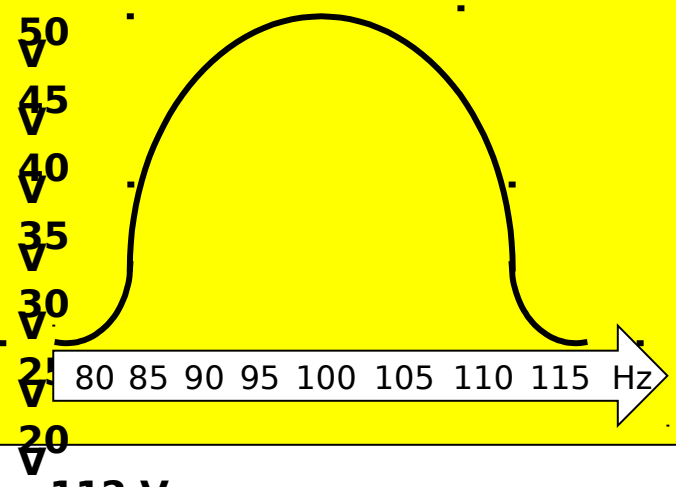
c. f2 _____

d. f1 _____

e. BW _____

f. BW Frequencies _____

g. Q _____



10.

a. F_R _____

b. 1/2 Pwr Pt V _____

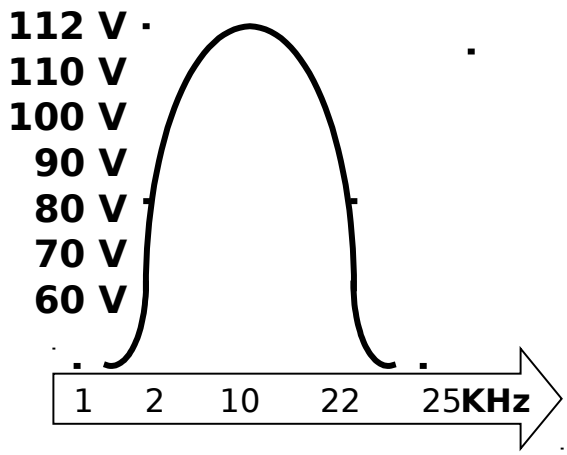
c. f2 _____

d. f1 _____

e. BW _____

f. BW Frequencies _____

g. Q ____



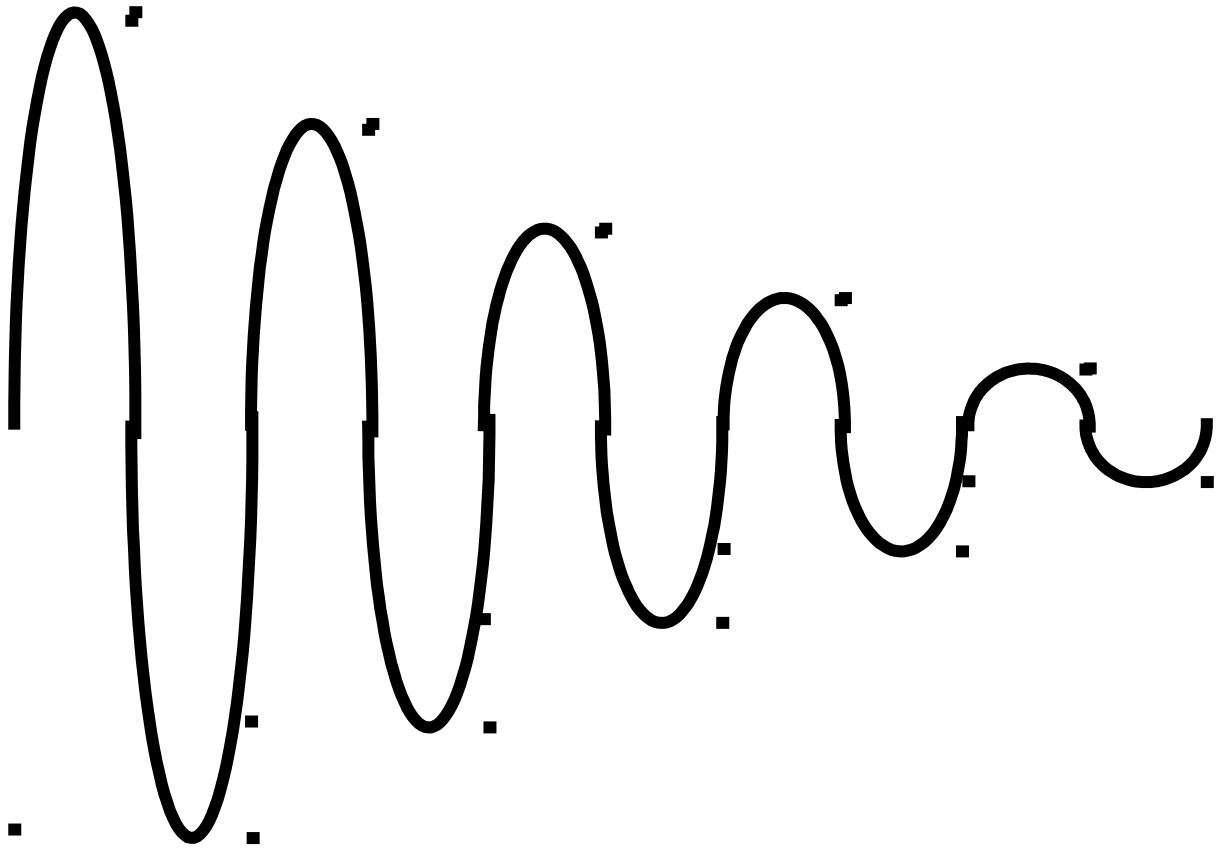
TIII:

Sinewave Oscillators

Unclassified

4 Hour Conference, W/ 6Hr PE1

Safety & Environmental Impact is "LOW"



TIII: Sinewave Oscillators

Lesson Terms;

<u>Oscillator</u> [Osc]; The basic signal generating source for electronics Ckts.

1. **Converts DC to AC.**
2. **Operates in the Audio & Radio Range, AF & RF.**
3. **4 Requirements of an Osc** { Free running or No external AC source}
   - **a. DC Voltage.**
   - **b. Regenerative Feedback, [**Sustains the Oscillations**].**
   - **c. An Amplifier.**
   - **d. Frequency Determining Device, [FDD].**

<u>Dampening</u>; Diminishing signal strength due to Ckt loss inherent in Osc.

The Ckts ability to maintain a constant signal amplitude & frequency

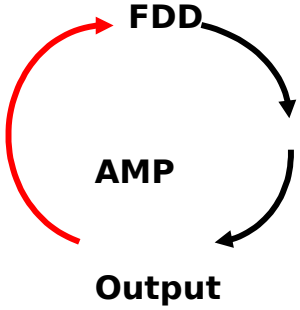
Types; **1. Tank Ckt.**

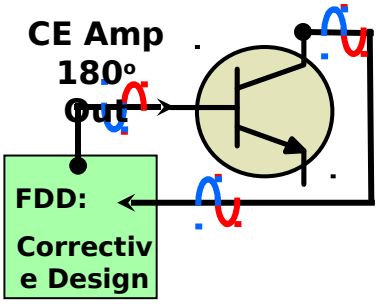
Regenerative Feedback; Sustains the Oscillations.

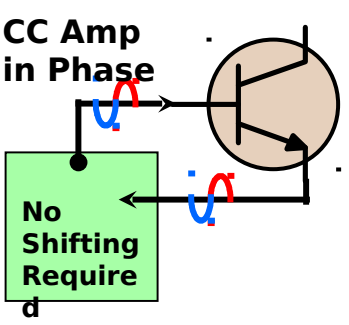
Regenerative Feedback;

maintain

1. **When the part of energy in the Ckt is used to sustain or the Oscillations in the FDD & <u>prevents Damping</u>.**
2. **Feedback must be in Phase from the output to the input.**
3. **A 180° Phase shift will cancel out the Osc.**
   {Corrective design will overcome the 180° phase shift**}**.

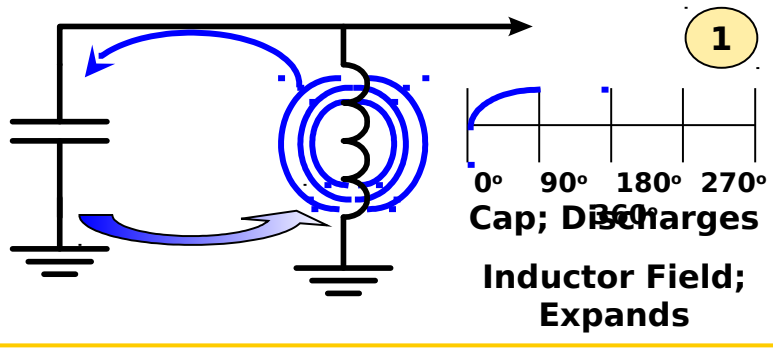


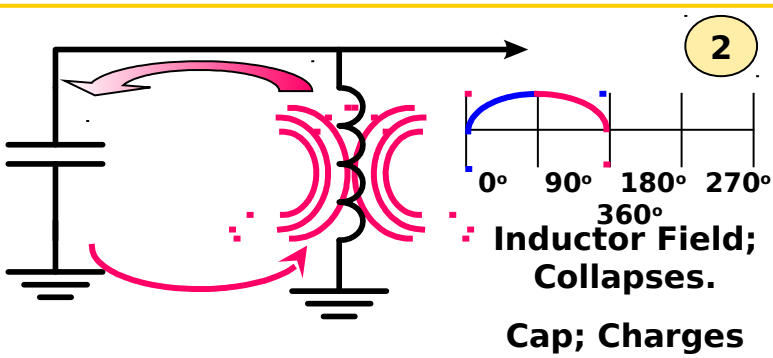


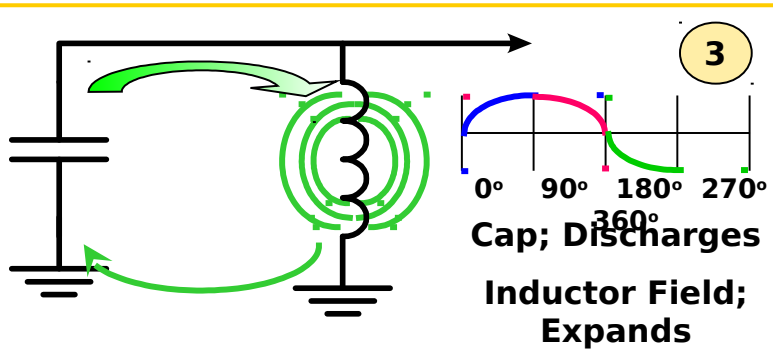


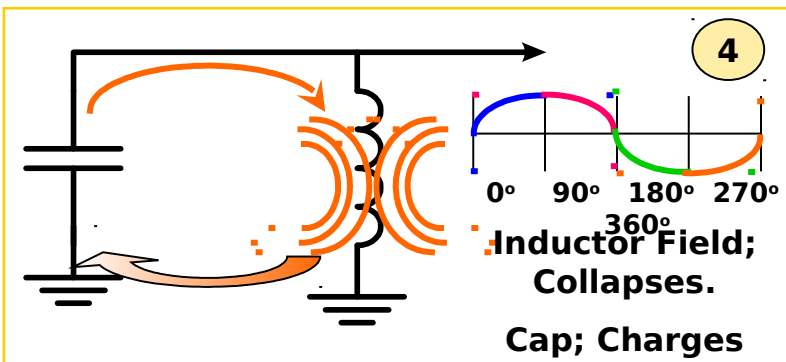
TIII: Sinewave Oscillators

Tank Ckt Ops; Parallel Resonate Ckt.









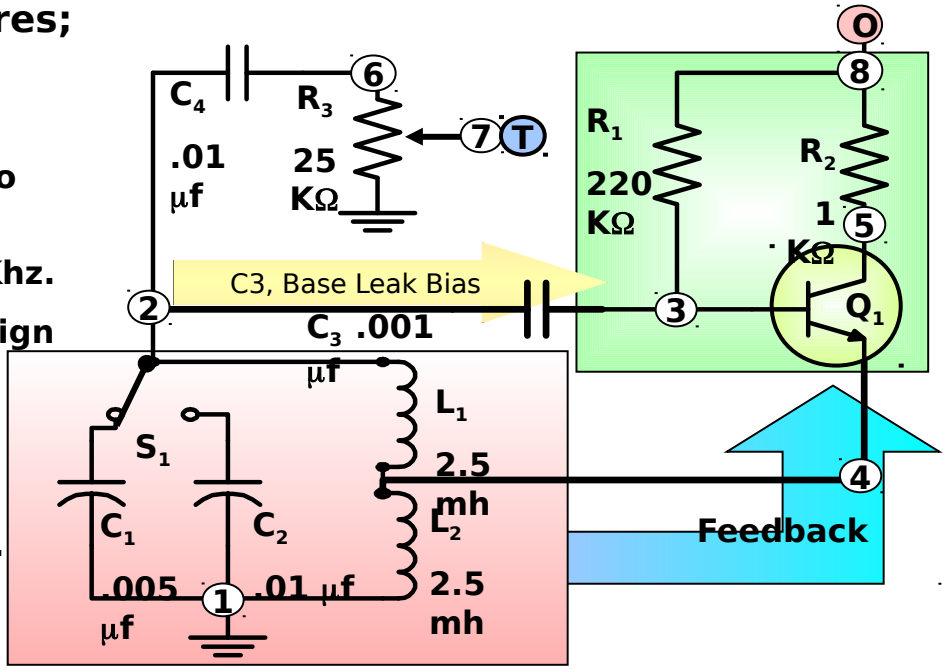
TIII: Sinewave Oscillators

Hartley Oscillator PC 35; Block Diagram.

Creature Features;

1. **ID by Split Inductors.**
2. **Ops @ Audio Frequency**

   [AF] 20HZ-20Khz.
3. **Output, is a Sign wave.**
4. **Most efficient @ Class C Ops.**
5. **Not very stable.**



Hartley Oscillator PC 35; Component & Ckt ID.

Pin O; DC Applied

C1, 2. L1, 2; [FDD]

Q1; Amplifier, Class C Ops. [Acts as a Switch]

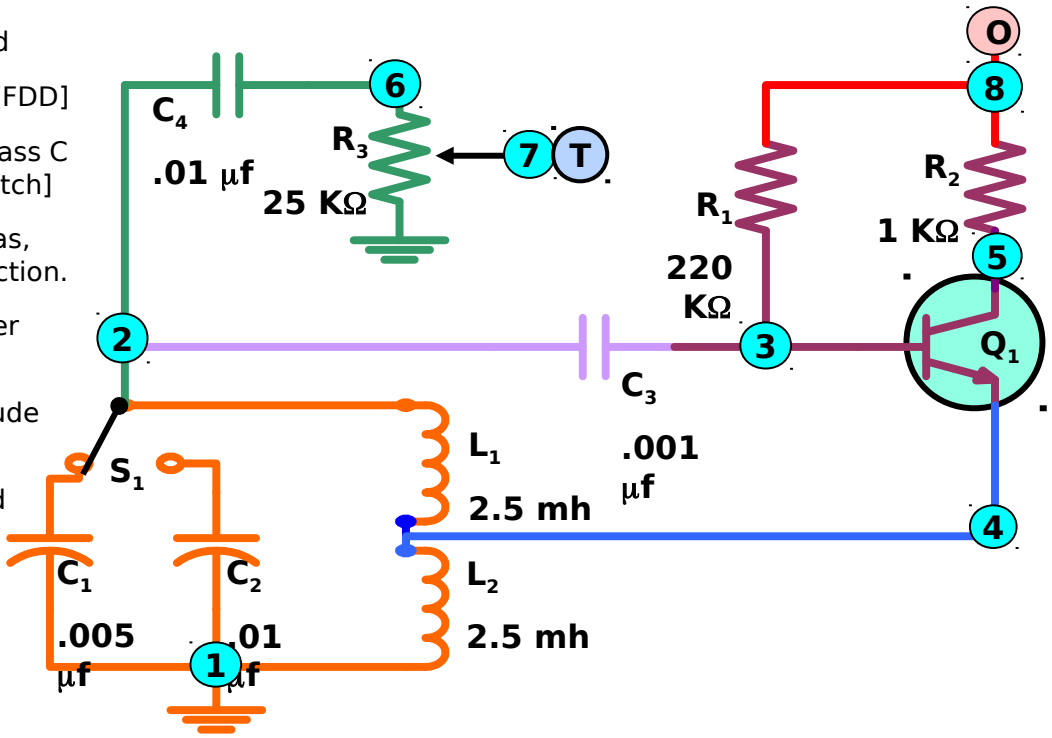
C3; Base Leak Bias, Controls Q1 conduction.

C4; Output Coupler W/R3.

R3; Varies amplitude of output Signal.

R2; Collector Load resistor.

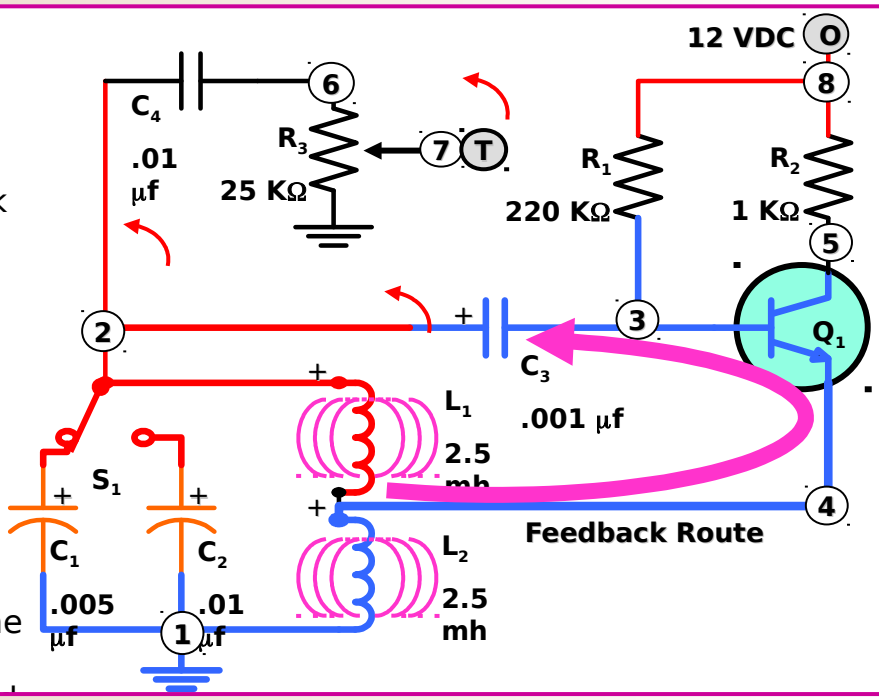
R1; Controls discharge rate of C3 [RC TC].



TIII: Sinewave Oscillators

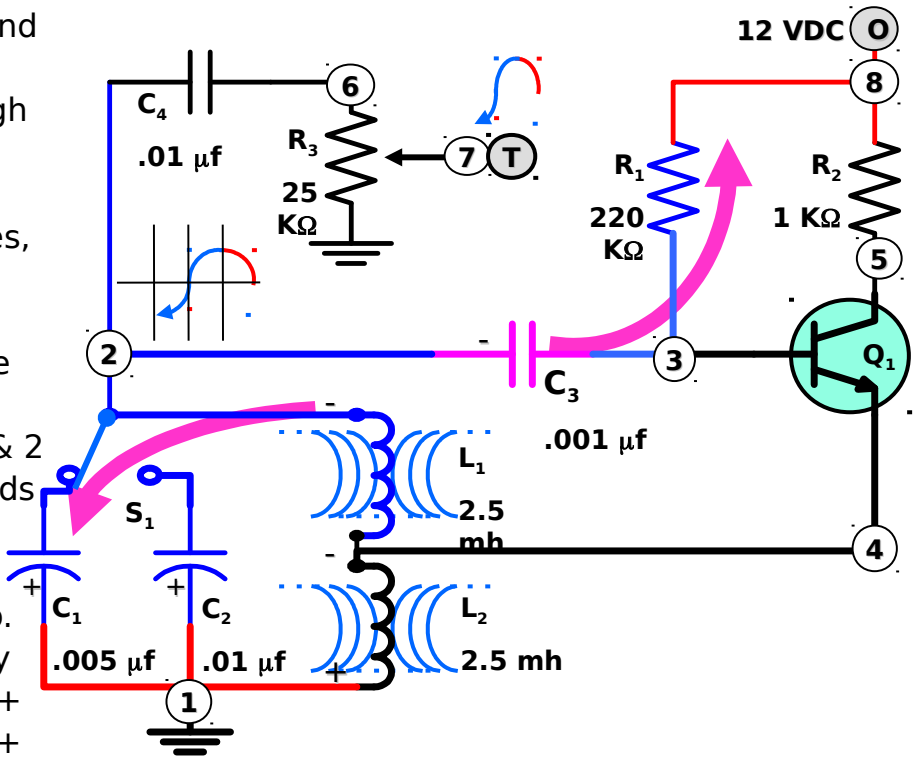
PC 35; 12 VDC applied,Tank Energized, Q_1 On.

1. W/DC applied, Q1 Conducts & C3 Charges.
2. Current flows Through L1 setting up the respective polarities, tank action starts.
3. C1 or C2 Charges then discharges thru L1 & 2
4. + is placed on C3 allowing it to Charge.
5. Output Wave form begins.
6. Feedback, is accomplished each time Q1 conducts, allowing current to flow through the Tank [FDD].



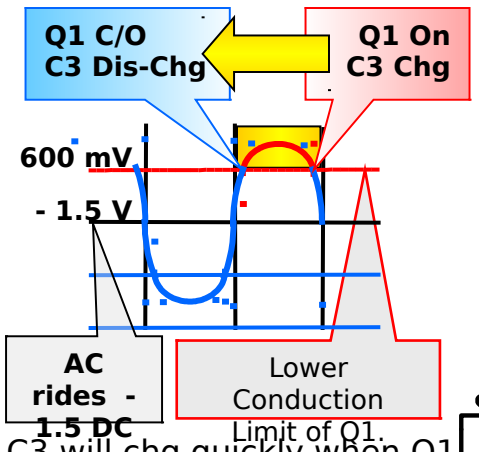
PC 35; Q_1 Cuts Off.

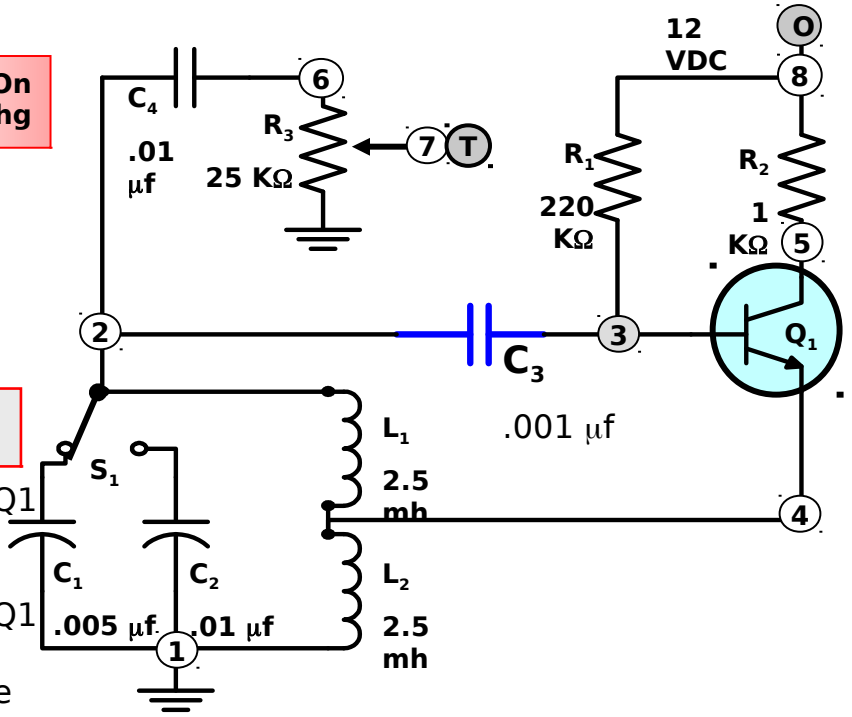
1. C3 Charges rapidly, and drives Q1 into Cutoff.
2. C3, Discharges through R1, RC TC determines discharge time.
3. L1 & 2 Fields Collapses, C1 & 2 charges @ 90o-180o
4. - is placed on C3 plate allowing it to Discharge.
5. From 180o -270o C1 & 2 will Dis-Chg, L1 & 2 Fields Expand
6. Output Wave form Proceeds from 90o-270o.
7. C3 expends its energy from 270o heading in a + direction it will become + enough for Q1 to Conduct again..



TIII: Sinewave Oscillators

Hartley Oscillator PC 35; C3 Base Leak Bias.





C3 will chg quickly when Q1 conducts.

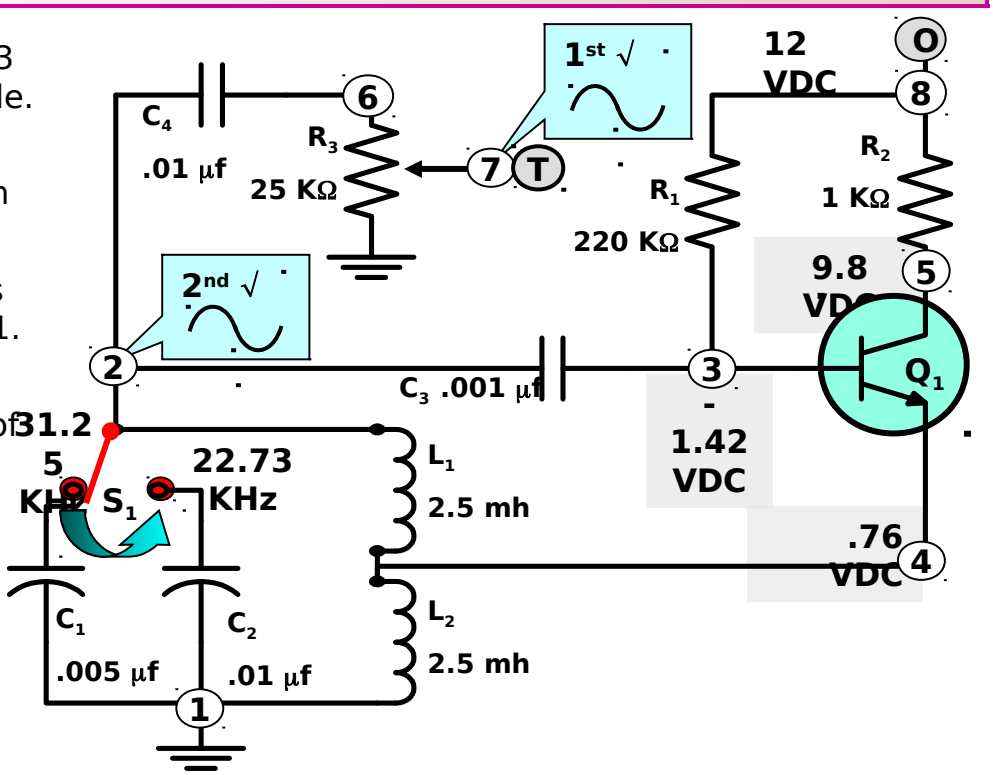
C3 will Discharge slowly through R1 driving Q1 into Cutoff for the majority of the cycle

Troubleshooting Procedure.

1. **TP7,** Output, R3 Adjust Amplitude.
2. **TP2,** No Signal Change position S1.

   If Signal returns problem is in C1.

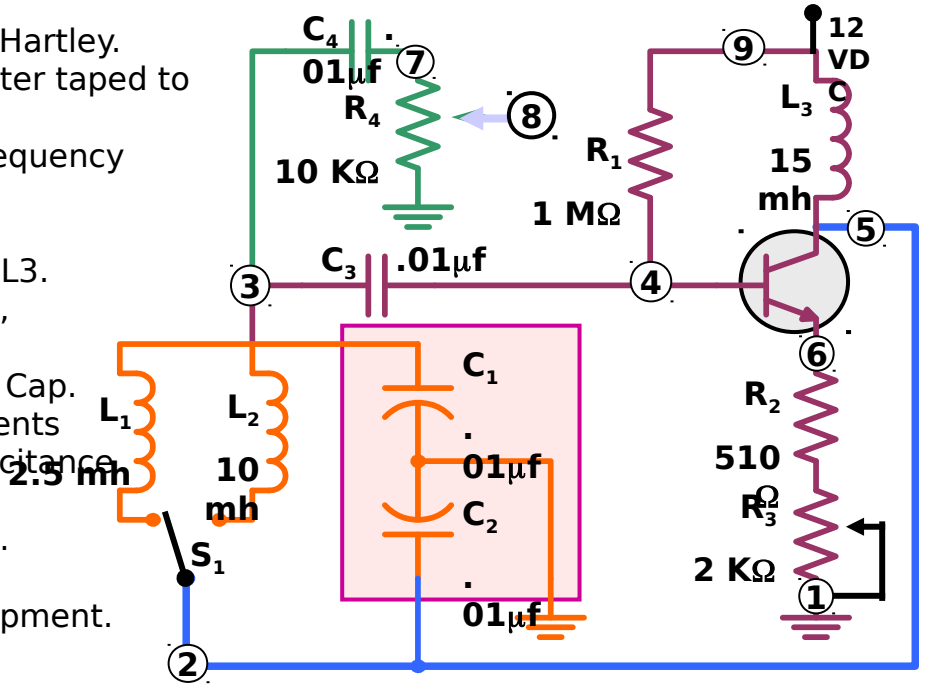
   TP2, Signal in Both positions of S1.
3. **DC Checks** on Q1 TP 5, 3, 4.



TIII: Sinewave Oscillators

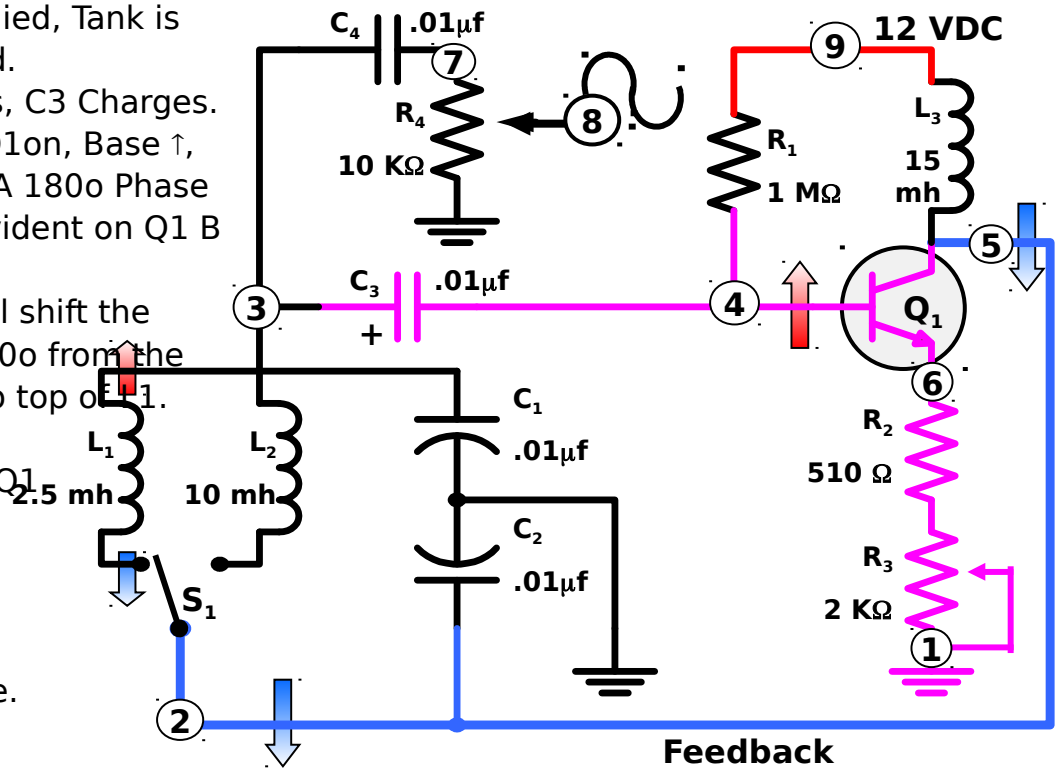
Colpitts Oscillator, PC 36; Component & Ckt ID.

1. More Stable than a Hartley.
   ID by split Caps center taped to Gnd.
   Ops in the upper Frequency range.
2. **FDD**, L1, 2. C1, 2.
3. **Amp**, Q1, R1, 2, 3, L3.
4. **C4**, Output Coupler,
5. **R4** adjustable.
6. **C3**, Base Leak Bias Cap.
7. **L3**, RF Choke, Prevents Interelectrode Capacitance due to high Freq.
   a. Prevents Pwr Loss.
   b. Ensures 360o wave form development.



Colpitts Oscillator, PC 36; Q1 Conducts.

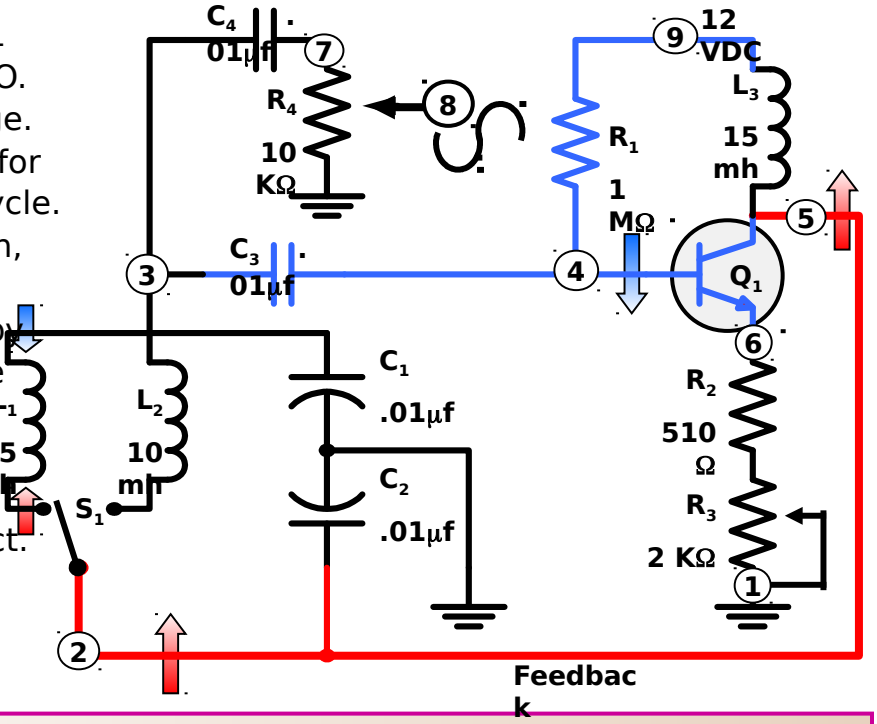
1. 12 VDC applied, Tank is energized.
2. Q1 conducts, C3 Charges.
3. Feedback; Q1on, Base ↑, Q1 C ↓. A 180o Phase shift is evident on Q1 B -C.
4. The Tank will shift the Signal 180o from the bottom to top of T1.
5. When C3 is Charged Q1 Will be driven into C/O.
6. C3 Will then Discharge.



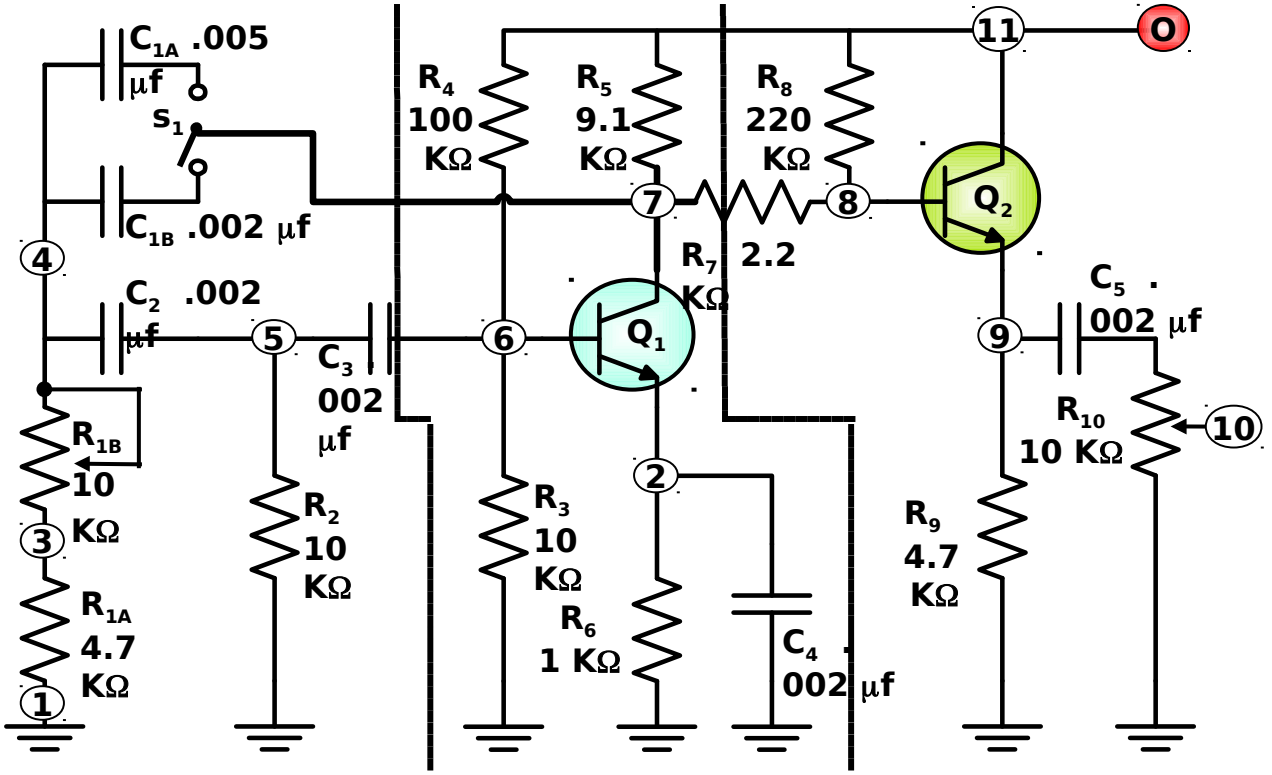
TIII: Sinewave Oscillators

Colpitts Oscillator, PC 36; Q1 Cutoff.

1. When C3 is Charged, Q1 Will be driven into C/O. C3 Will then Discharge.
2. Q1 will remain in cutoff for the majority of the cycle.
3. Q1 is acting like a switch, only when sufficient energy is expended by C3 does the waveform become positive enough to cause Q1 to conduct.
4. The Colpitts Ops much like the Hartley Osc.



RC Phase Shift Oscillator, PC 37; Component & Ckt ID.



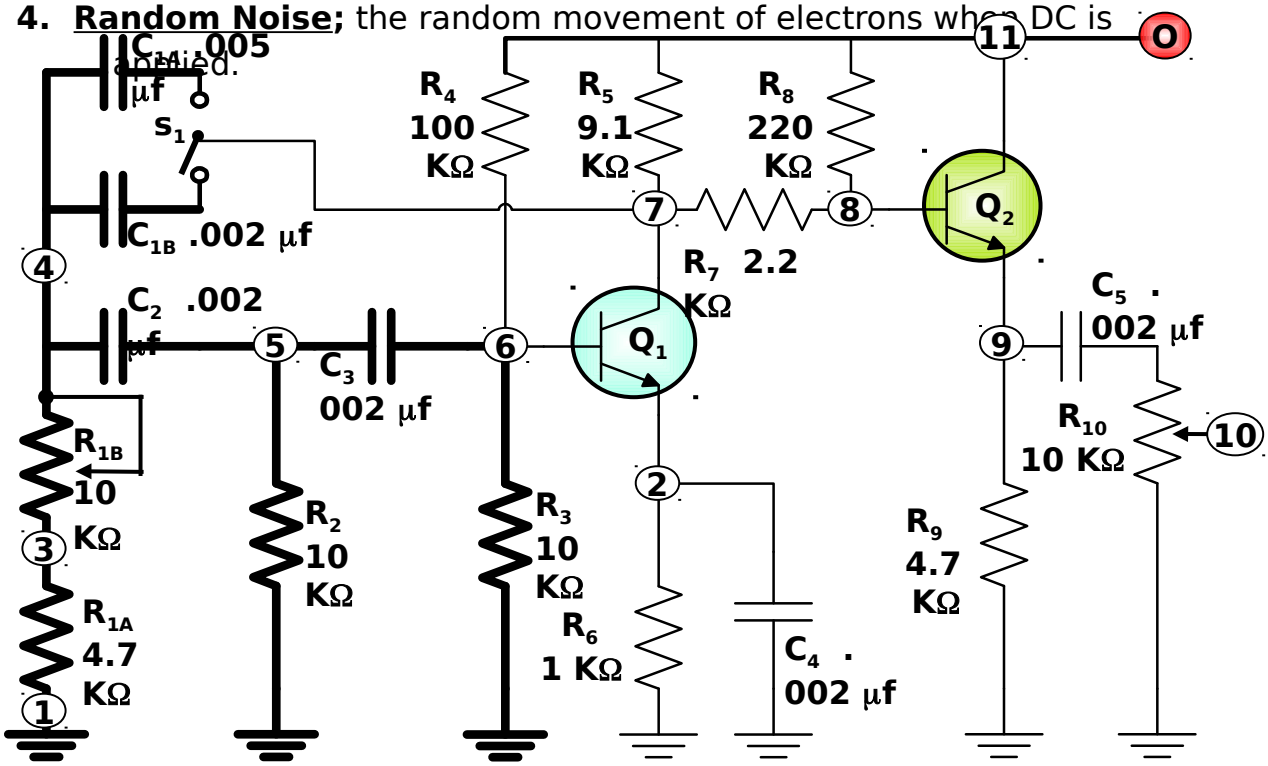
TIII: Sinewave Oscillators

RC Phase Shift Oscillator, PC 37; Component & Ckt ID.

1. **FDD;** C1A or C1B, R1A & R1B, C2-R2, C3-R3.
2. **Feedback;** From Q1 Collector [180o out] through the FDD.
3. **AMP;** Q1, class A. Common Emitter.
4. **Buffer;** Q2, Common Collector. Isolates the oscillator from changes in load.
5. **Stability**; Medium.

RC Phase Shift Oscillator, PC 37; FDD

1. **Feedback**; From Q1 Collector through the FDD.
2. **Each RC** Ckt **shifts** the signal **60o**.
   C1A or C1B, R1A & R1B. 60o
   C2 - R2. 60o
   C3 - R3. 60o
   3 X 60o = 180o
3. **FDD** works on the principle of Random Noise selectivity filtered by the RC TC.
4. **Random Noise;** the random movement of electrons when DC is applied.



TIII: Sinewave Oscillators

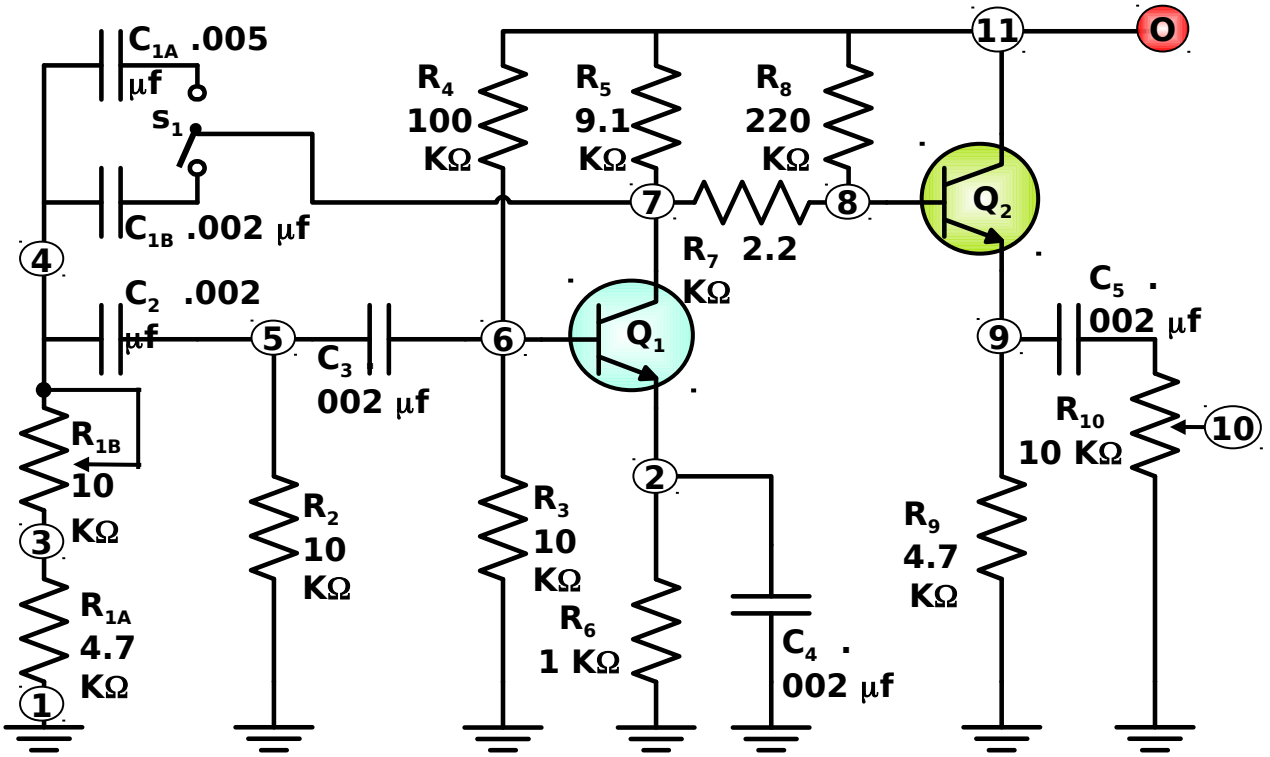
RC Phase Shift Oscillator, PC 37; Signal Injection.

1. Signal check @ TP10 & TP7
2. If all DC Voltages are near normal the malfunction is in the Osc.
3. Signal Inject @ Tp5 O-scope probe @ Tp6, Checks C3 & R3
   Signal Inject @ Tp4 O-scope probe @ Tp5, Checks C2 & R2
   Signal Inject @ Tp7 O-scope probe @ Tp4, Checks C1a,b & R1a,b

Normal

C# Ok
R# Open

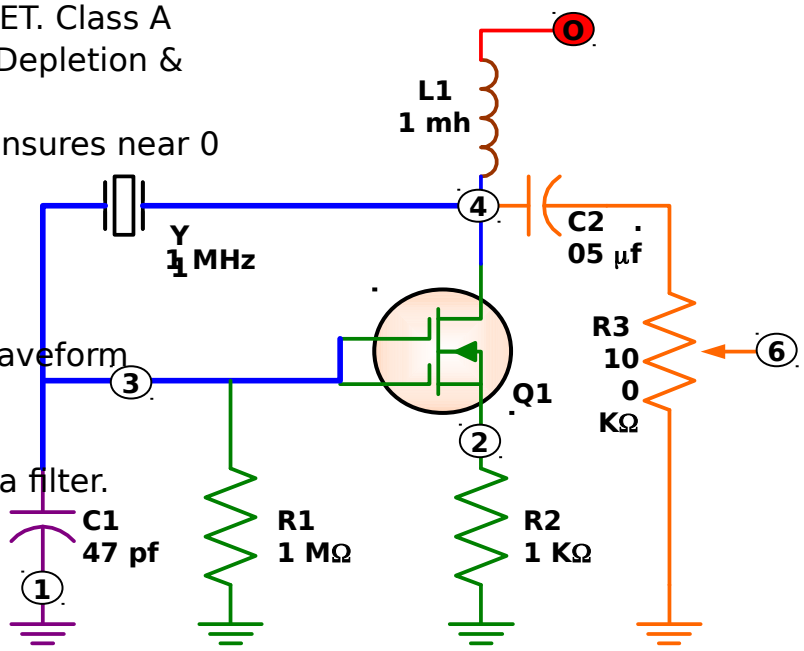
C# Open
R# Short



TIII: Sinewave Oscillators

Crystal Oscillator, PC 50; Component & Ckt ID.

1. **FDD;** Y1 Crystal,
2. **AMP;** Q1, Dual Gate MOSFET. Class A Amp, N channel type, Depletion & Enhancement mode.
3. **R1 & 2;** Set Q1 Bias, R1 ensures near 0 volts @ the Gate.
4. **L1;** RF Chock, prevents power loss @ high Frequencies & ensures 360o Waveform development.
5. **C1;** Eliminates Harmonic Freq from Ckt. Acts as a filter.
6. **C2 & R3;** Output coupler.
7. **Feedback;** Q1 Drain 180o out of Phase.
8. **Y1;** Crystal.



Piezo Electric, Crystals.

1. **Crystals, Stability is the best,** used to generate carrier wave transmission, Microphones & Speakers.
2. **Piezo Electricity, [Piezo electric effect];** The process of converting Mechanical stress to Electrical, or vise versa.
3. **Crystal Benefits;** Cheap, Plentiful {Quartz}, Strong, can be cut & sliced to operate W/in specific ranges, Maintains its stability.
4. **High Current will burn a crystal.**
5. **Operational/ Physical Characteristics;**

Crystal slab thickness determines the resonance frequency. There can be more than one.

Lowest; called the Fundamental Frequency**.**

Higher; called the Overtones. Usually a multiple of the fundamental frequency.

Thinner the slice the higher the frequency

TIII: Sinewave Oscillators

PC 50, Troubleshooting Sequence.

Symptoms:

TP6 _____

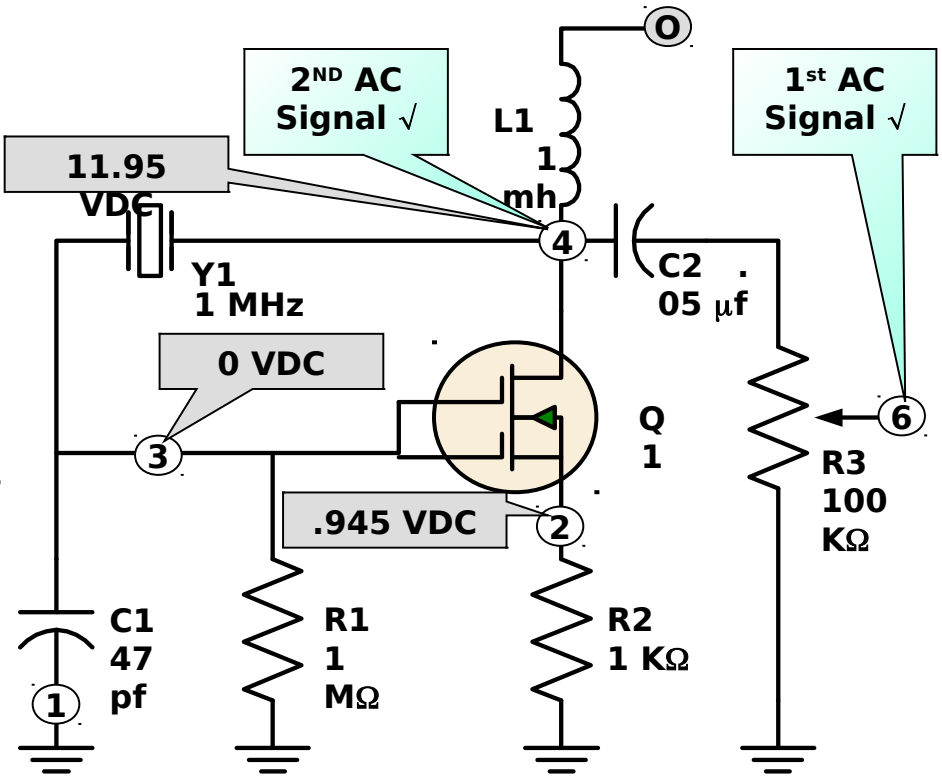
TP4 _____

TP4 = 11.64 VDC

TP3 = .0447 VDC

TP2 = 11.64 VDC

Trouble shooting is accomplished just like any other transistorized Ckt.



Review Questions:

1. **What are the four requirements for a circuit to function as an oscillator? a._____b._____c._____d._____**
2. **Name the four oscillators discussed in this lesson. a._____ b._____c._____d._____**
3. **Why is regenerative feedback required in oscillators? _____**
4. **Name some examples of frequency determining devices studied in this lesson. _____ _____ _____**
5. **What type of characteristic is displayed in quartz crystals. _____**
6. **What is the identifying feature of a Hartley Oscillator? _____**
7. **What is the identifying feature of a Colpitts Oscillator? _____**
8. **What component [s] determine [s] the output frequency of the series fed Hartley Oscillator? _____**
9. **What class of operation is most efficient for a Colpitts or Hartley Oscillator. _____**

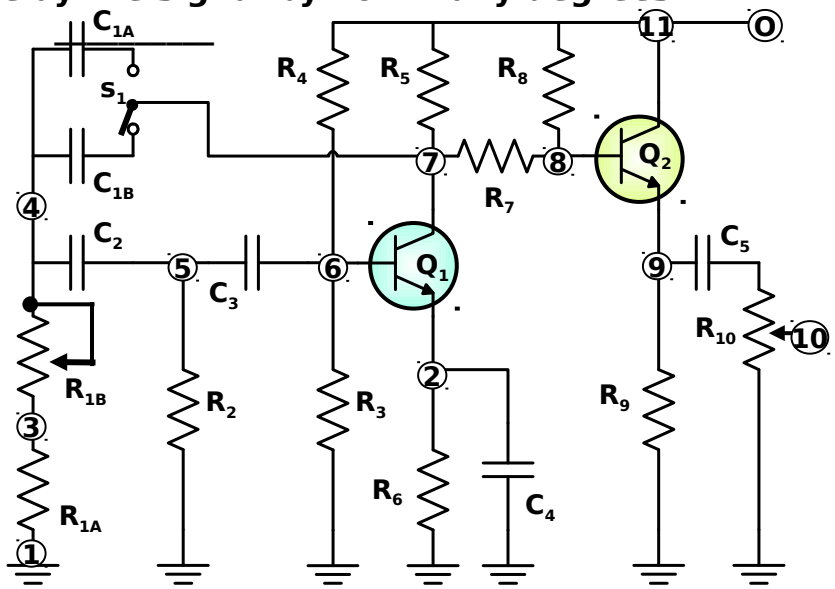
Review Questions:

10. Refer to PC 37. The component combination C3 R3 will shift or delay will shift or delay the signal by how many degrees?

11. Refer to PC 37. How much phase shift is provided by the entire phase shift network? _____

12. What is the purpose of Q2 ? _____

13. How is the frequency of PC 37 established ? <u>Principle of Operation</u> _____



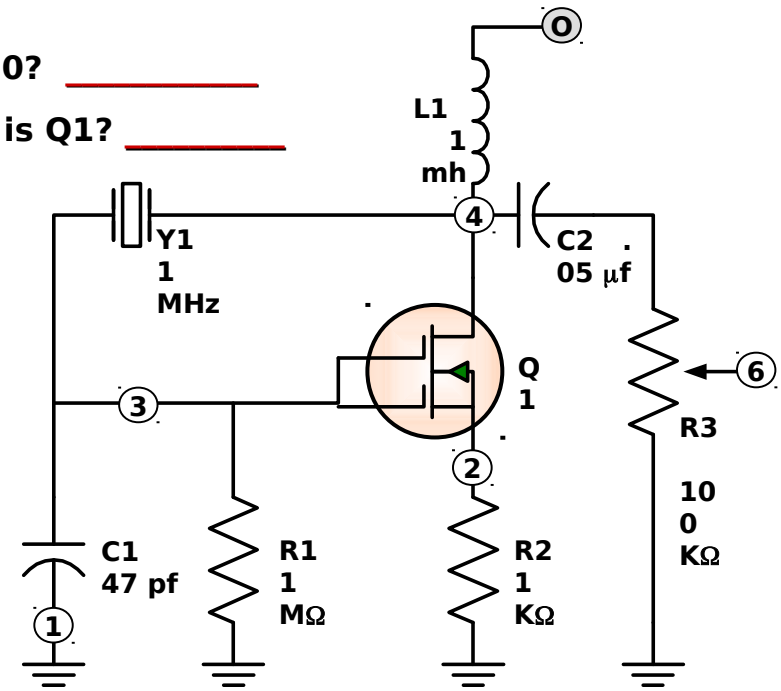
14. What is the FDD in PC 50? _____

15. What kind of transistor is Q1? _____

16. Why are Crystals especially useful in radio communications equipment? _____

17. What is the most commonly used material to make an oscillator crystal? _____

18. What is meant by Resonant Frequency? _____



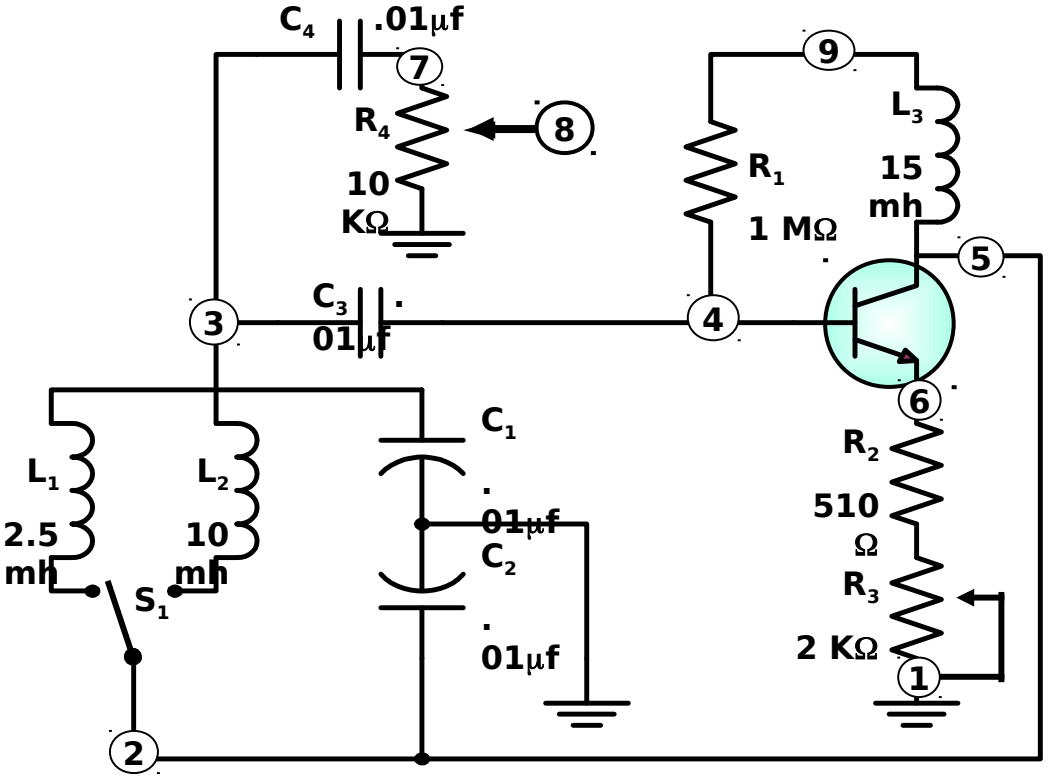
19. The thinner the Crystal _____ the Its resonance frequency.

TIII: Sinewave Oscillators

Review Questions:

20. Refer to PC36. What is the purpose of L3? _____

21. What is the usual output of the Hartley or Colpitts Oscillator? _____

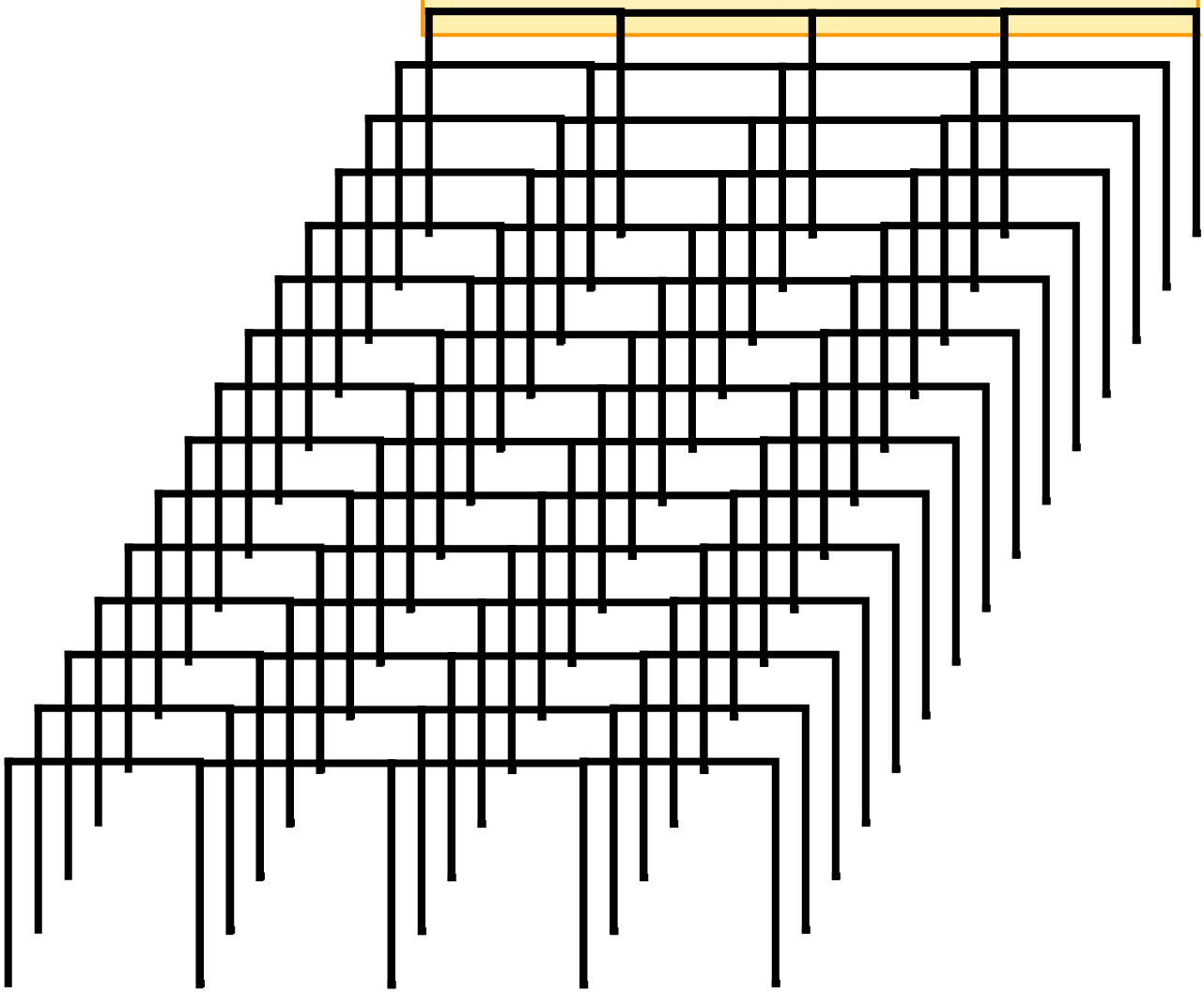


Blocking Oscillator

Unclassified

2 Hour Conference, W/ 5 Hr PE1

Safety & Environmental Impact is "LOW"

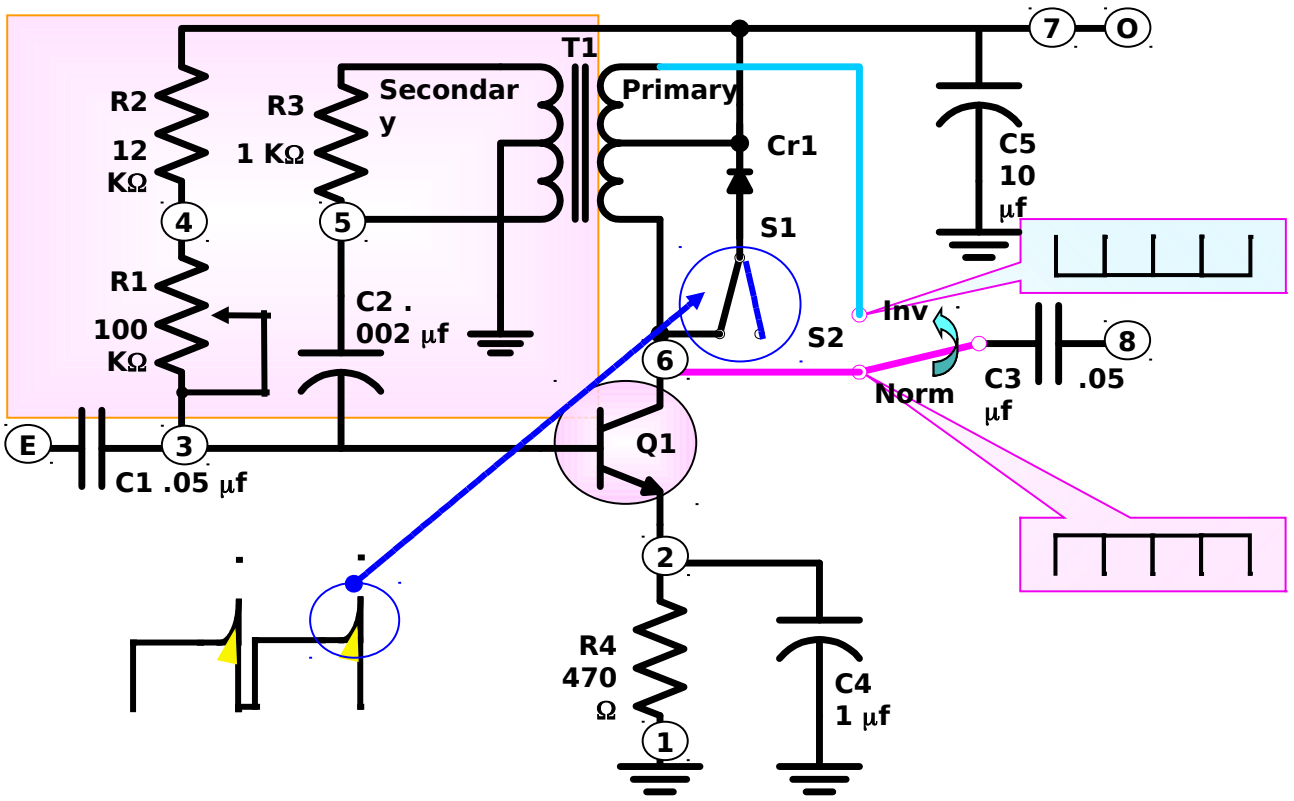


TIII: BLOCKING OSCILLATOR

Creature Features;

1. **Blocking Osc, used as a Master Oscillator;**
   a. Generates Pulses in short duration [Very narrow Pulses].
   b. Triggers or Synchronizes other Ckts.
2. **Three basic forms or modes of operation.**
   a. Free running [Astable].
   b. Synchronized [Loss of trigger reverts to Free Running].
   c. Triggered [depends entirely on an external source].
3. **Also known as a Relaxation Oscillator.**
   a. It generates a non-sinusoidal waveform by quickly charging a capacitor & slowly discharging it through a resistor, [Quick charge slow discharge].
   b. The output is reflective of Q1 conducting & C2 discharging.
4. **PRF,** Pulse Repetition Frequency.

PC 42; Ckt & Component ID



TIII: BLOCKING OSCILLATOR

PC 42; Ckt & Component ID

C1; Input coupling Cap, used in the Synchronized & Triggered mode only.

R1&2; Sets DC base bias for Q1. R1 Controls the rate of discharge of C2 & Varies the Freq of the output. **R Freq**

C2; Base Leak Bias Cap, controls Q1 Conduction, holds Q1 in Cutoff.

R4; Sets DC Emitter Bias. Prevents thermal runaway.

C4; Degeneration Cap.

Q1; CE Amp, used as a switch.

Cr1; Prevents ringing in primary of T1.

S1; Engages Cr1 to prevent ringing in T1p.

R3; Swamping Resistor, prevents ringing in the Secondary of T1.

T1; Collector Load, provides feedback to Q1 Base to change conduction.

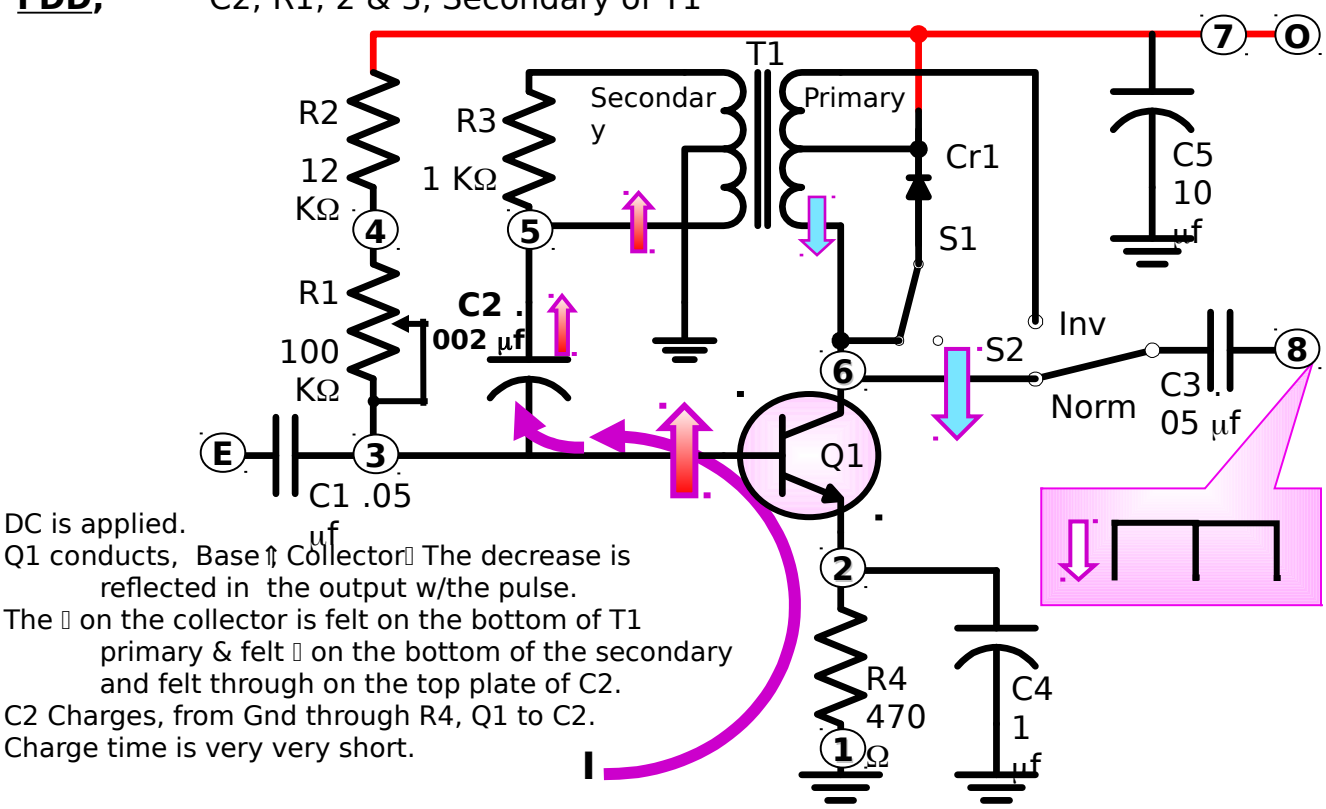
S2; provides a Neg pulse in the Norm position taken from Q1 Collector. A Pos Pulse on the Invert position, taken from top of T1 Primary.

C3; Output Coupling Cap.

C5; Decoupling Cap, [Shunt to Gnd] Acts as a filter sending any signal development to Gnd, keeps ac from running back into DC Pwr supply.

FDD; C2, R1, 2 & 3, Secondary of T1

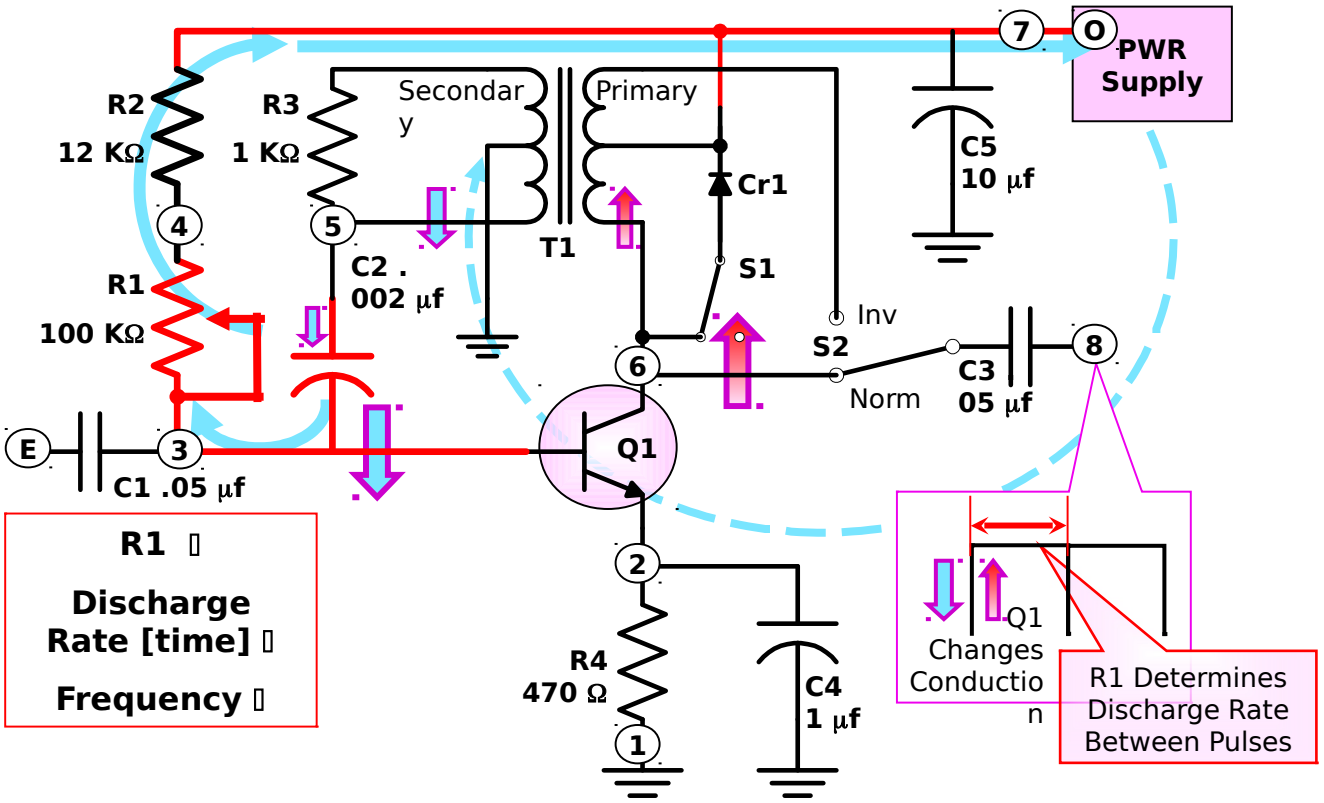
PC 42; Free Running, Q1 Conducts, C2 Charges.



DC is applied.
Q1 conducts, Base ⇑ Collector The decrease is reflected in the output w/the pulse.
The on the collector is felt on the bottom of T1 primary & felt on the bottom of the secondary and felt through on the top plate of C2.
C2 Charges, from Gnd through R4, Q1 to C2.
Charge time is very very short.

TIII: BLOCKING OSCILLATOR

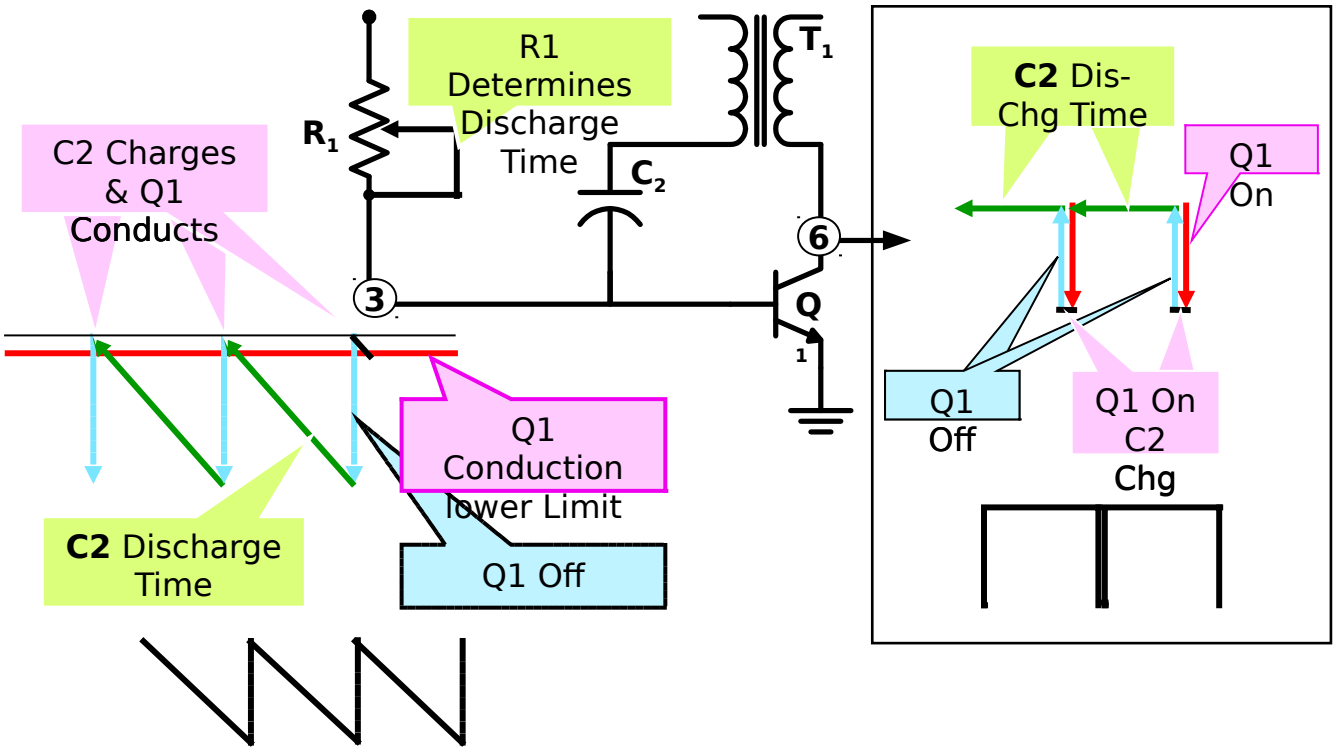
PC 42; Free Running, C2 Discharges, Q1 Cut Off.



1. C2 is charged & slams the Base of Q1 down into C/O.
2. Base ⇓ Collector▯ output Pulse is completed.
3. When Collector goes ▯ it is felt on bottom of T1 primary and felt as a ▯ on bottom of secondary, that is felt through onto the top plate of C2.
4. C2 Discharges, keeps Q1 C/O, the time between the pulse is now being started.
5. Complete Path for discharge is through R1, R2, Pwr Supply, Pwr supply Gnd, T1 Secondary Gnd tap, back to top plate of C2.
   Ringing is caused by discharge current flow seeing two paths on the secondary Winding, that is acting like an inductor in a tank Ckt, R3 offers opposition to any oscillation that would occur, Cr1 in the primary feels the field expansion in the secondary [by means of mutual induction] forward biasing Cr1 & provides a ready path to Gnd suppressing oscillations.
6. R2 dictates the time duration of C2 Discharge thus the time between each pulse.
7. RC time constant is in effect, R2 is adjustable, ▯ resistance of R2 and C2 discharges faster & Q1 conducts sooner.

TIII: BLOCKING OSCILLATOR

PC 42; Free Running, Base & Collector signal development.



"READ SIGNALS RIGHT TO LEFT"

Illustration Left of Schematic: Base signal [saw-tooth] On the Right; Collector, output, [Narrow pulse]:
When Dc is first applied, Q1 conducts, C2 is Charged.
Output; Change of conduction is seen on Collector a plateau is formed reflecting the amount of time it takes to charge C2 Before it cuts off.

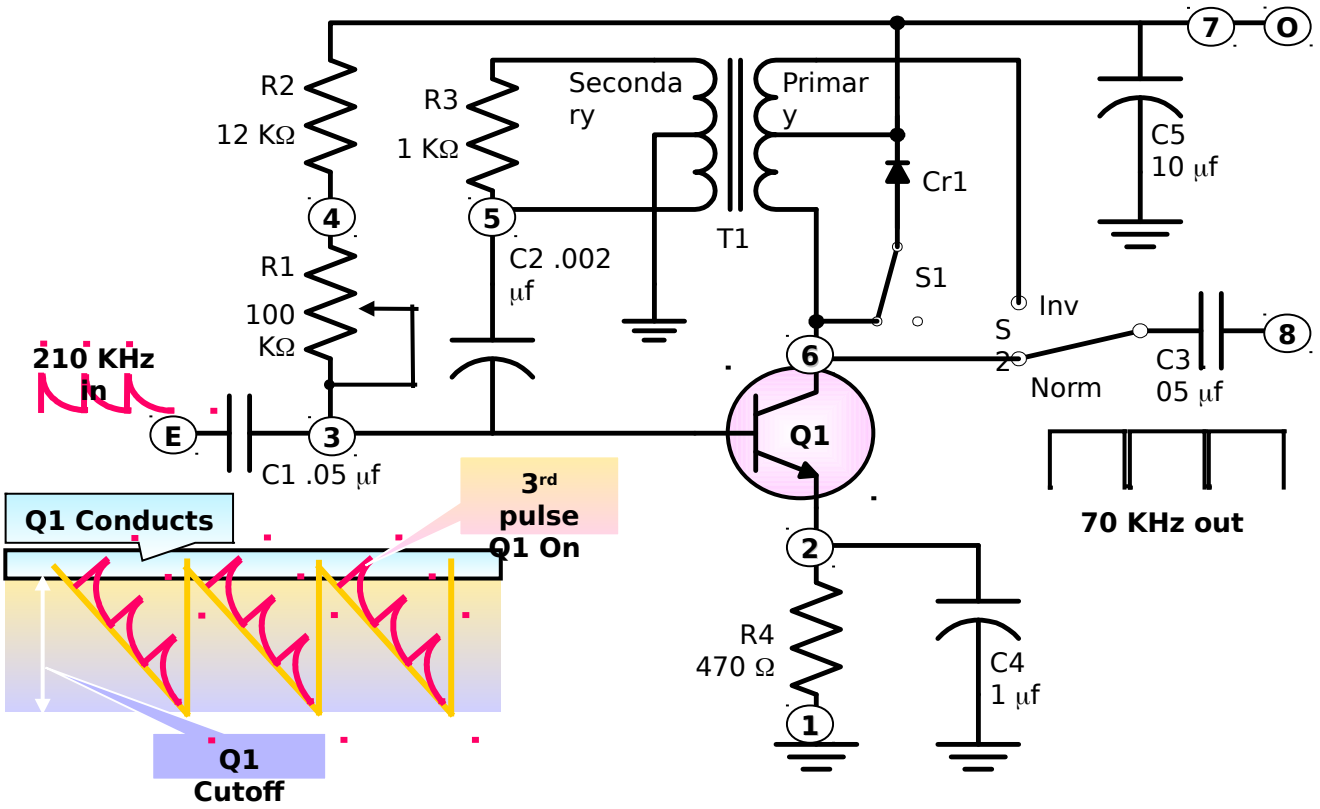
2. When C2 is sufficiently charged It will slam the Base & the Collector the Pulse is completed.

3. C2 will start its discharge, the rate or time is dictated by the Resistance of R1 [RC TC]. On the Base saw-tooth [diagonal arrow] it progresses from most negative and as it gives up its stored energy & becomes progressively more positive, until it is positive enough to reach the lower limit of Q1 conduction.
On the Output; The plateau Arrow reflects the time of C2 Discharge & the time between pulses.

Note; the Base is in C/O for the Majority of the cycle, its DCV when measured will be negative Volts DC.

TIII: BLOCKING OSCILLATOR

PC 42; Synchronized Mode.



SYNCHRONIZED MODE:

Synchronize; To lock one element or signal of a system, in step w/another.
In the synchronous mode, an external AC signal is received @ pin E.
The input AC Trigger will ride the Base signal [Saw-tooth] an cause Q1 to conduct sooner, thus resetting the time sequence & Frequency.
Dependent upon the number of Input triggers riding the discharge portion of the Saw-tooth [3 Illustrated] will determine the output frequency, Hence the term Frequency Divider.

Note; R1 can be adjusted to accommodate more triggers or less triggers riding the saw tooth.

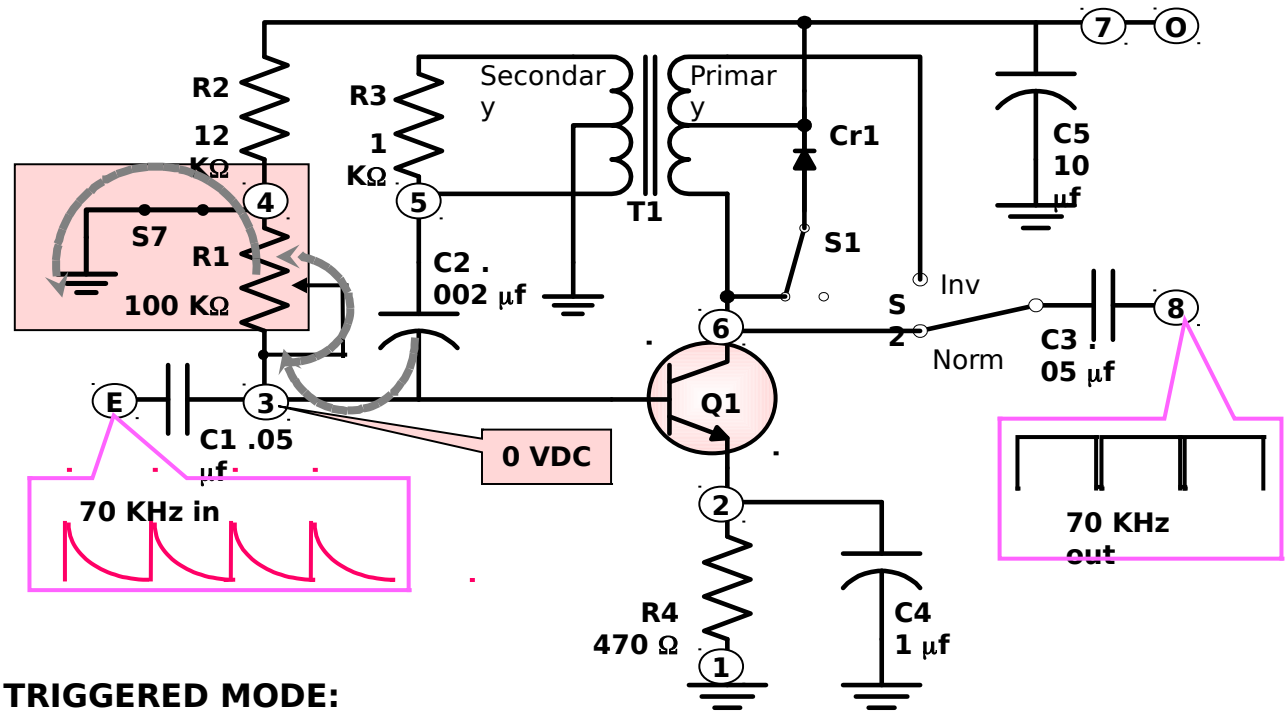
If the Sync Pulses or triggers are ended [either by malfunction or intent] the device will revert to the Free Running Mode.

210 KHz In [Trigger] ÷ 3 [3 triggers riding Saw-tooth] = 70KHz Out.

{210 KHz ÷ 3 = 70KHz}

TIII: BLOCKING OSCILLATOR

PC 42; Triggered Mode.



TRIGGERED MODE:

Dependent entirely on an external AC source. If the Trigger is lost the Oscillator shuts down.

Frequency IN = Frequency OUT.

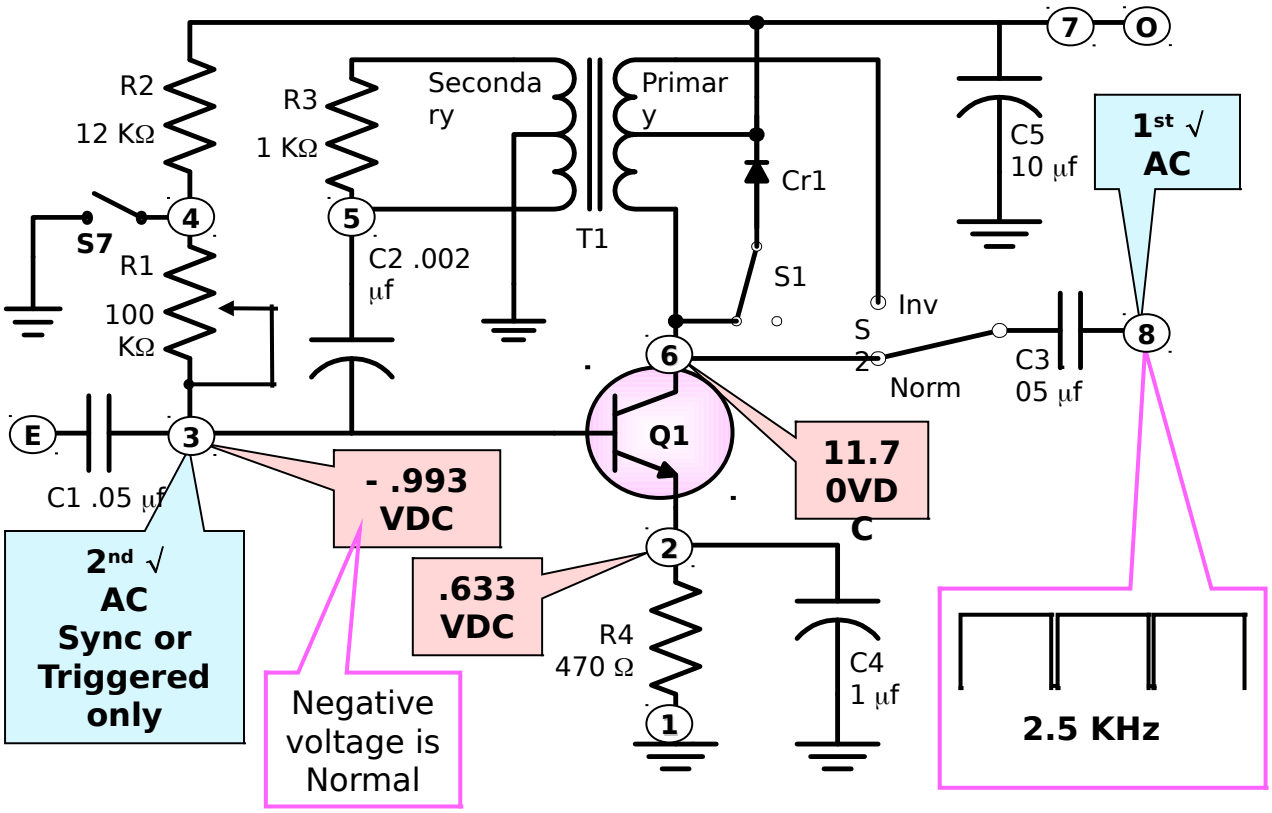
Input trigger of sufficient amplitude will forward bias Q1, A pulse will occur on the Output.

S7 IS the Key to Operation, W/ S7 closed, 0 VDC is found on the Base. Discharge of C2 is none effective, S7 is grounded and electrically is the same point as the top plate as C2, the most effect C2 has is ensuring conduction change occurs quickly as the trigger passes.

If R2 were to Open while in the Triggered Mode, It would have no effect on operation, there would still be 0 VDC @ the Base.

TIII: BLOCKING OSCILLATOR

PC 42; Trouble Shooting, Sequence & Norms.

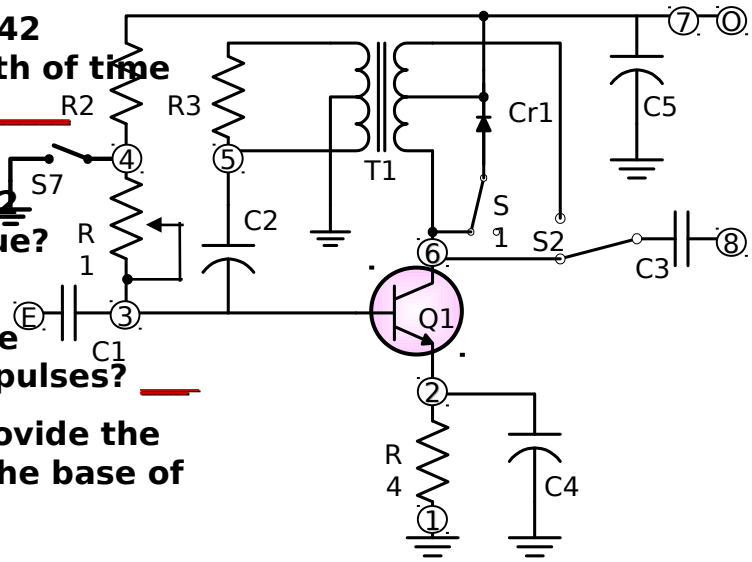


Trouble Shooting, Challenge. { Pay Close Attention to the Slide Schematics. }

Challenge #1	Challenge #2	Challenge #3	Challenge #4
TP8 = _____	TP8 = _____	TP8 = _____	TP8 = _____
TP3 = _____	TP3 = _____	TP3 = _____	TP3 = _____
TP6 = _____	TP6 = _____	TP6 = _____	TP6 = _____
TP3 = _____	TP3 = _____	TP3 = _____	TP3 = _____
TP2 = _____	TP2 = _____	TP2 = _____	TP2 = _____
TP_____ = ___	TP_____ = ___	TP_____ = ___	TP_____ = ___
Componate ____	Componate ____	Componate ____	Componate ____
OPEN or SHORT	OPEN or SHORT	OPEN or SHORT	OPEN or SHORT

TIII: BLOCKING OSCILLATOR

PC 42; Review Questions.



1. What components on PC 42 control [s] the length of time Q1 Conducts? _____

2. What will happen to the output frequency of PC 42 if R1 is increased in value? _____

3. What determines the time between the output pulses? ____

4. What Ckt componates provide the positive bias voltage to the base of Q1. _____

5. When do the output pulses from the Blocking Oscillator occur? _____

6. Refer to PC 42. The output @ TP8 is in Frequency, R1 does not adjust. What is the malfunction? _____

7. What is the purpose of CR1 on PC 42 ? _____

8. What controls the output frequency of the Triggered Blocking Oscillator. _____

9. What kind of output waveform does does PC 42 produce? _____

10. Refer to Pc 42 . R1 is Open. What would indicate this?

    a. 0 V on the Collector.

    b. 0 V on the Base.

    c. Higher than normal on the Emitter.

    d. VCC on the Emitter.

TIII: BLOCKING OSCILLATOR

PE;

1. Do Nita Lesson; Lesson ⇒ 3 ⇒ 5 Tran Osc, ⇒ 9 Blocking Osc.

2. PE Setup;

a. Set Trainer for 12 VDC

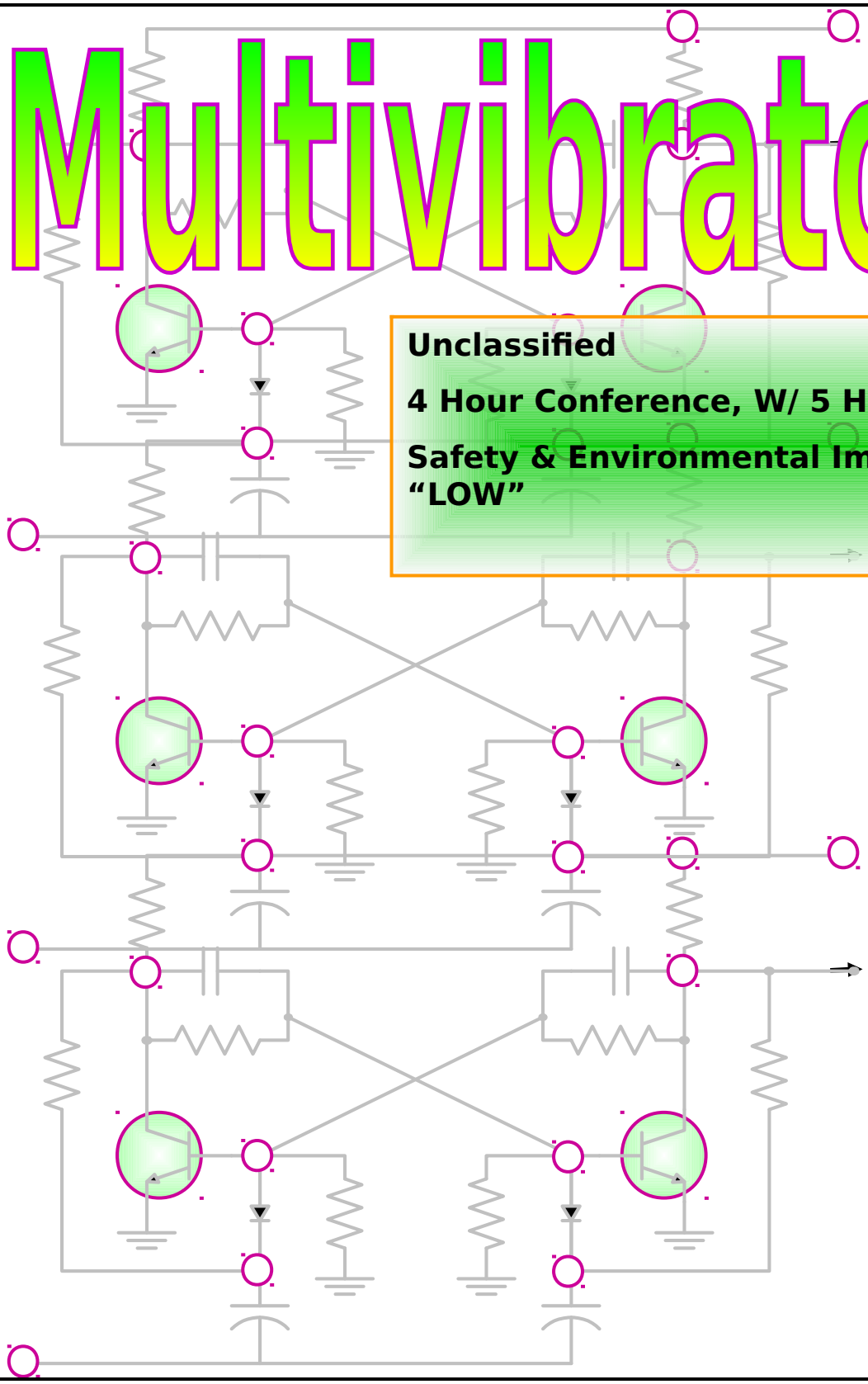
b. Adj. R1 For 2.5 KHz @ TP8

c. Get Normals.

d. Open S1 & look @ Ringing on the output signal.
When Finished, Close S1.

e. Shoot Bugs; F110 F112 F105 F106 F113
F111

Multivibrators



Unclassified

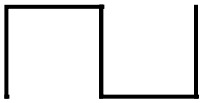
4 Hour Conference, W/ 5 Hr PE1

Safety & Environmental Impact is "LOW"

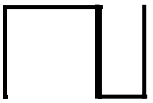
TIII: MULTIVIBRATORS

Creature Features: 3 Different Types

1. **Astable;** {PC 44}, No Stable State, Free Running.
   Output; Symmetrical or Asymmetrical Square waves.
2. **Mono Stable;** {PC 46}, 1 Stable State, Q5 C/O, Q6 Sat. Triggered.
   Output; Frequency In = Frequency Out.
3. **Bi Stable;** {PC 45}, 2 Stable States, Q3 C/O, Q4 Sat or Q3 Sat, Q4 C/O. Output; is ½ of the Input. Triggered.

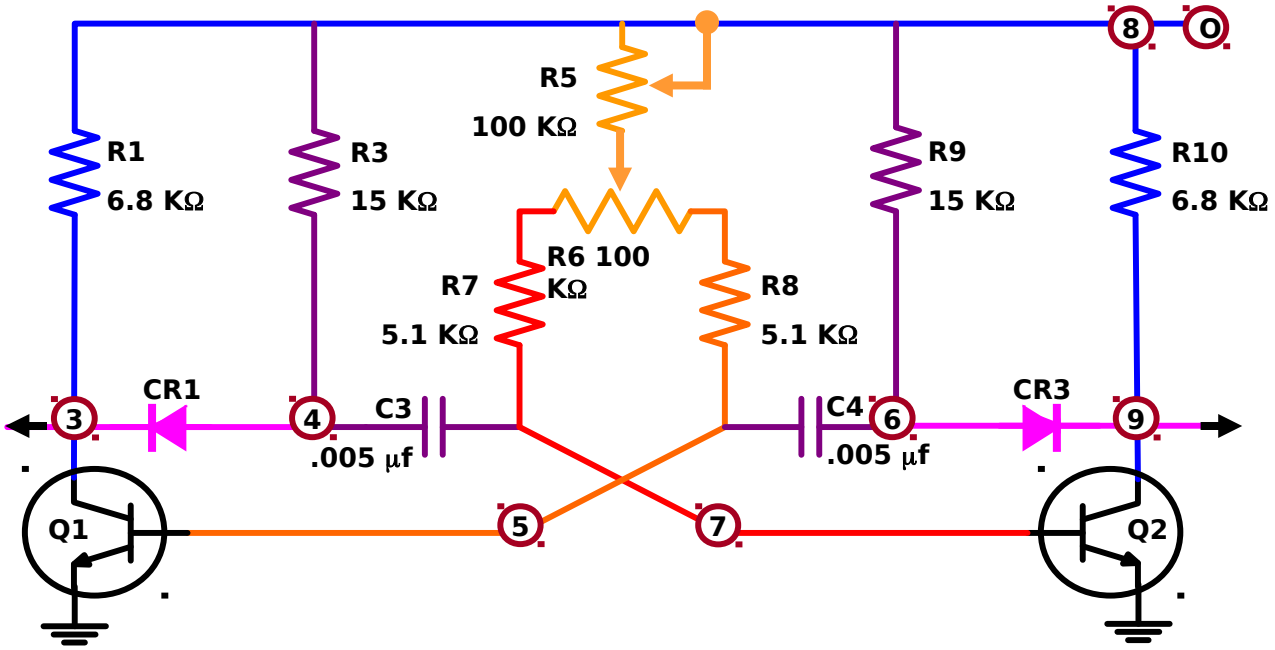


Symmetrical



Asymmetrical

Astable PC44: Circuits & Components



TIII: MULTIVIBRATORS

Astable PC44: Circuits & Components

R8, 6, 5; DC Base Bias Voltage Divider for Q1.
R7, 6, 5; DC Base Bias Voltage Divider for Q2.

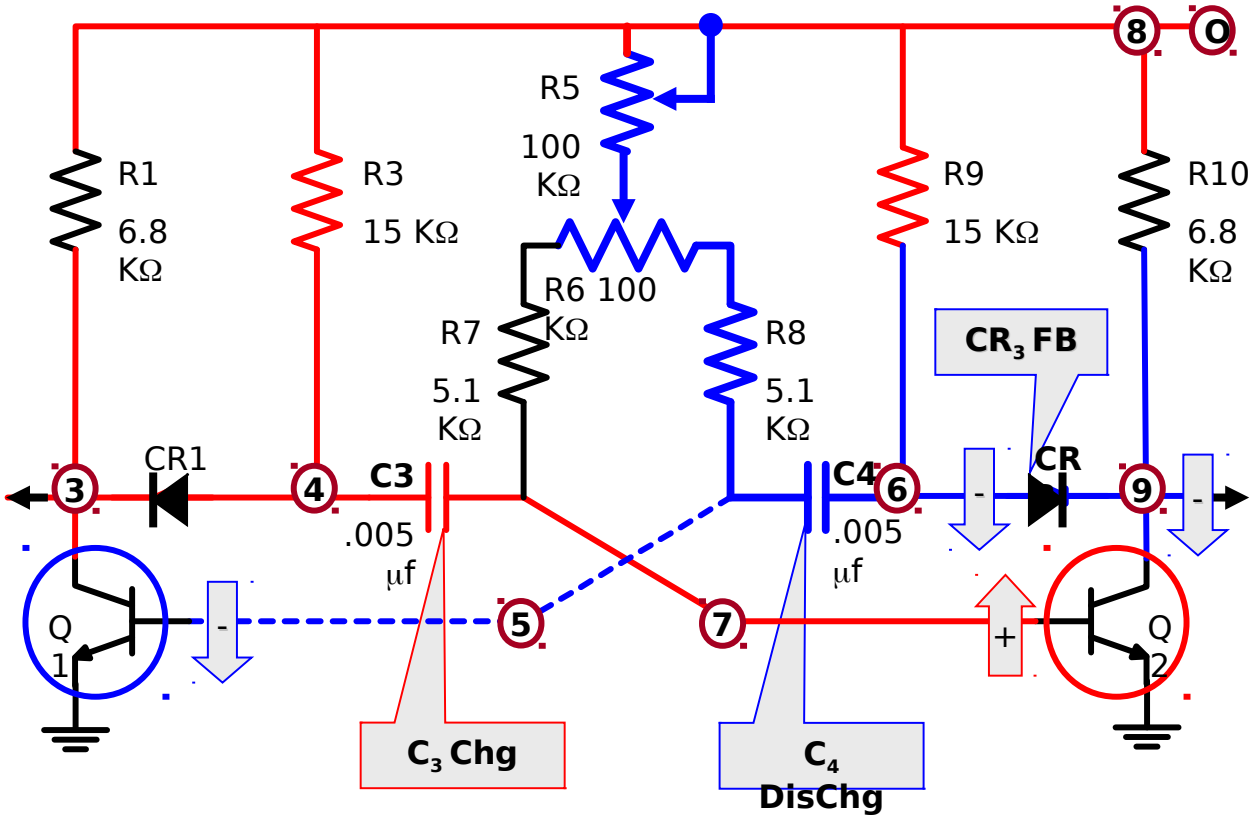
R6; Determines the symmetry by increasing / decreasing, discharges times of C3 & 4.
R7; Determines the Frequency by increasing or decreasing, Both discharges times of C3 & 4.
R1, 10; Collector Load Resistors.

CR1 & 3; Acts as switches to isolate TP9 & 3. Enables a Crisp leading edge on Squarewave.

C3 & 4; Coupling Caps [Collector to base]. C3 Discharge time determines Q2 time in cutoff. C4 Discharge time determines Q1 time in cutoff.

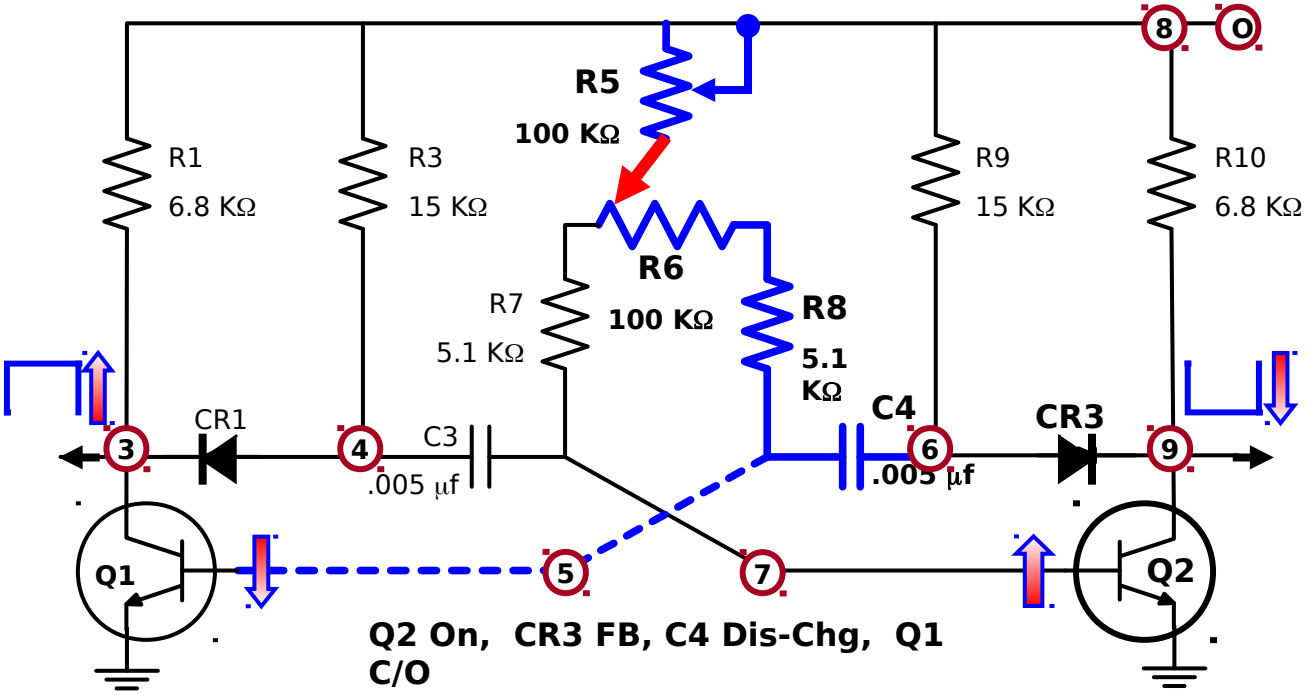
R3 & 9; Allows a + to be felt on Anodes of D1 & 2 and a + on the Plates of C3 &

Astable PC44: Q2 on, C3 Charge, C4 Discharge, Q1 C/O.

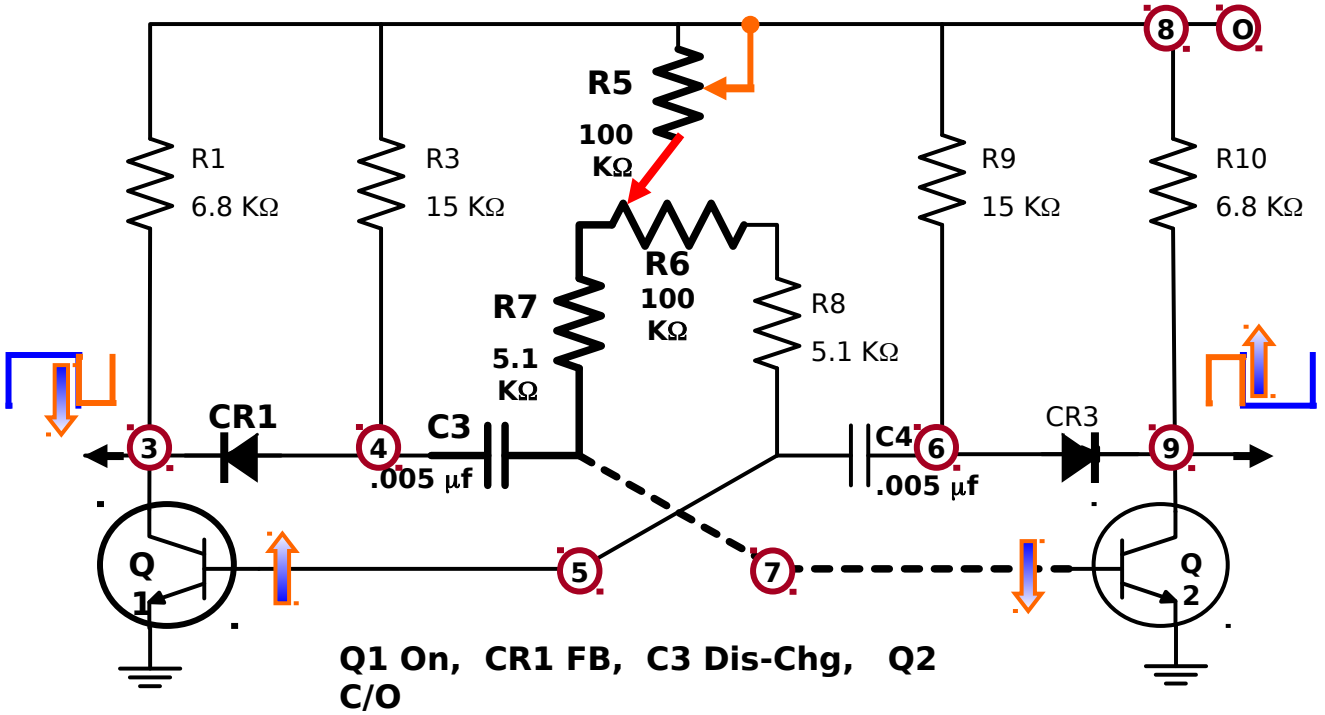


TIII: MULTIVIBRATORS

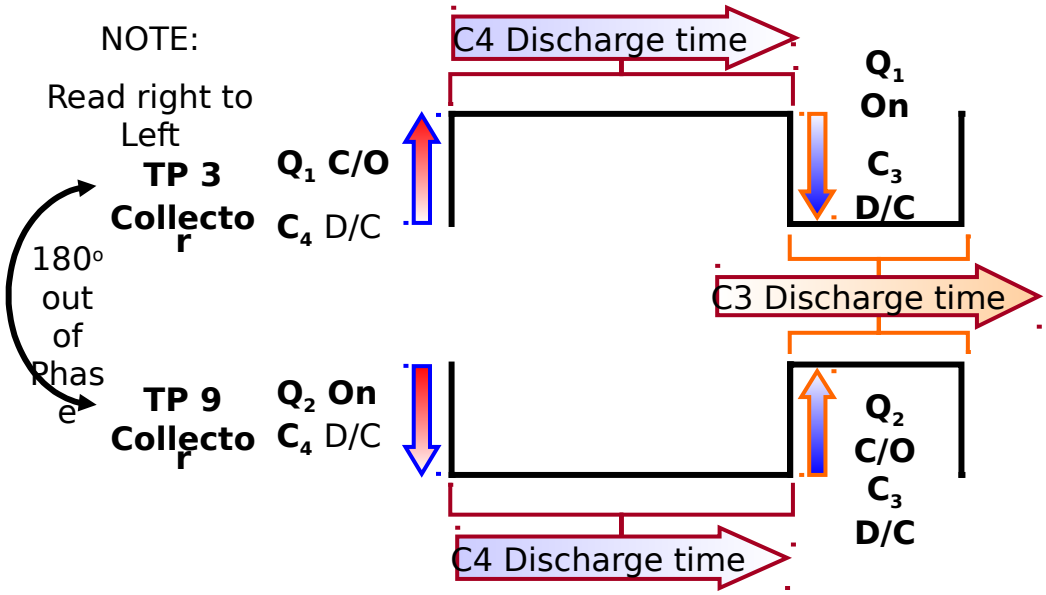
Astable PC44: Symmetry control, C4 Discharge.



Astable PC44: Symmetry control, C3 Discharge.



Astable PC44: Wave Form Analysis @ TP 3 & 9



TIII: MULTIVIBRATORS

Mono Stable PC46: Circuits & Components

MONOSTABLE: [one shot]

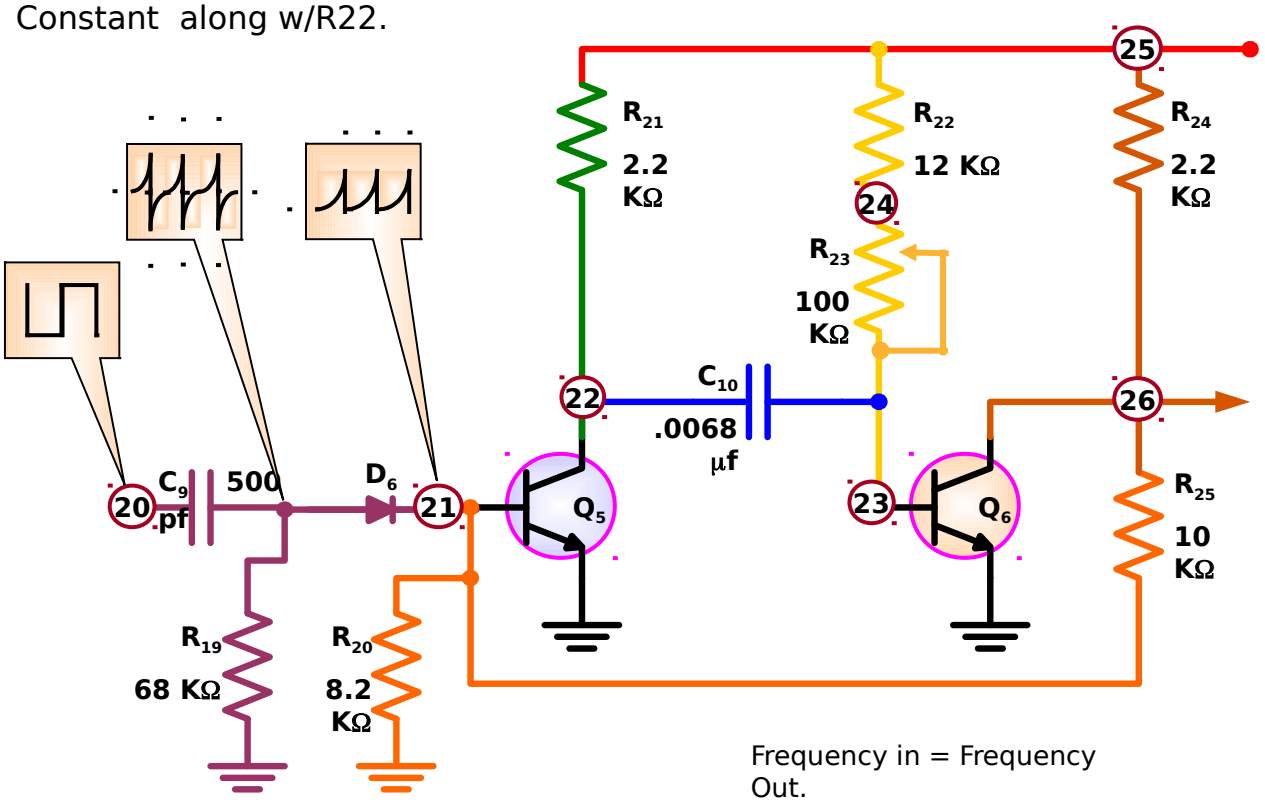
1 Stable State;
Q5 off Q6 on, Conducts in its stable state until it is triggered then reverses conduction [Q5 on Q6 off]

Components;
C9 & R19; Forms a Differentiator Ckt, Squarewave to Positive Negative Spike.
CR6 & R20; Converts a Positive Negative Spike, to a + pulse, that instigates the change of conduction of Q5.

R21 & 24; Collector load resistors.
R22 & 23; Dc Base biasing for Q6.
R24, 25, 20; Dc Base biasing for Q5.

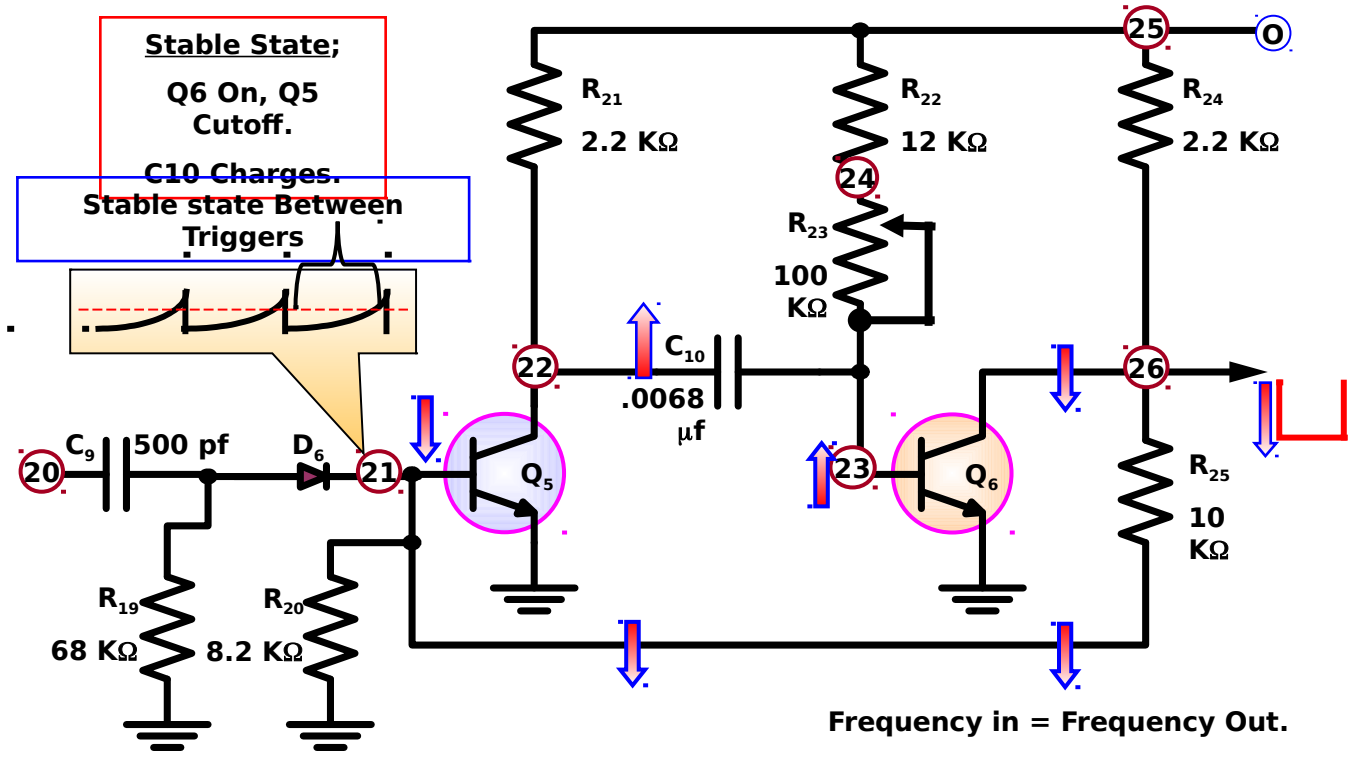
C10; Output Coupler from Q5 to Q6.
C10 discharge time determines the duration of Q6 cutoff & Q5 conduction.

R23; Varies the Pos PW. Work in conjunction w/C10 in the discharge Time Constant along w/R22.

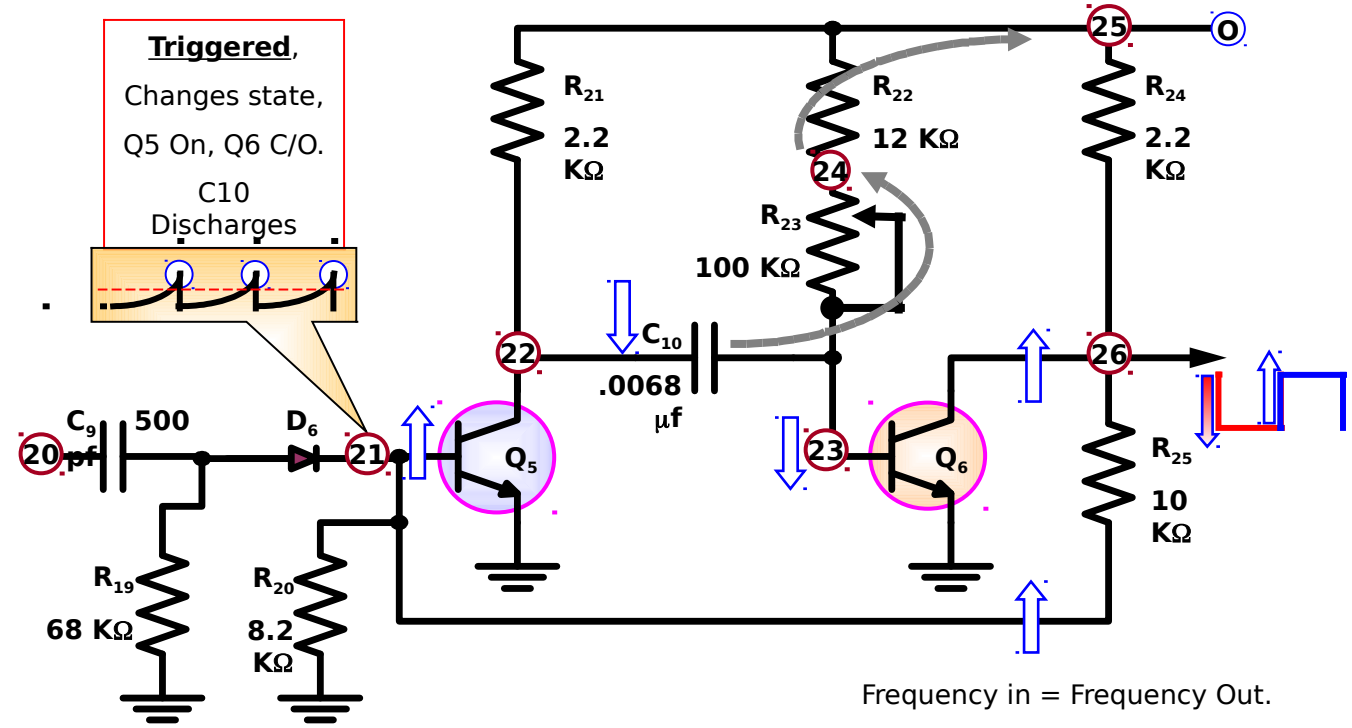


Frequency in = Frequency Out.

Mono Stable PC46: Ops, Stable State.

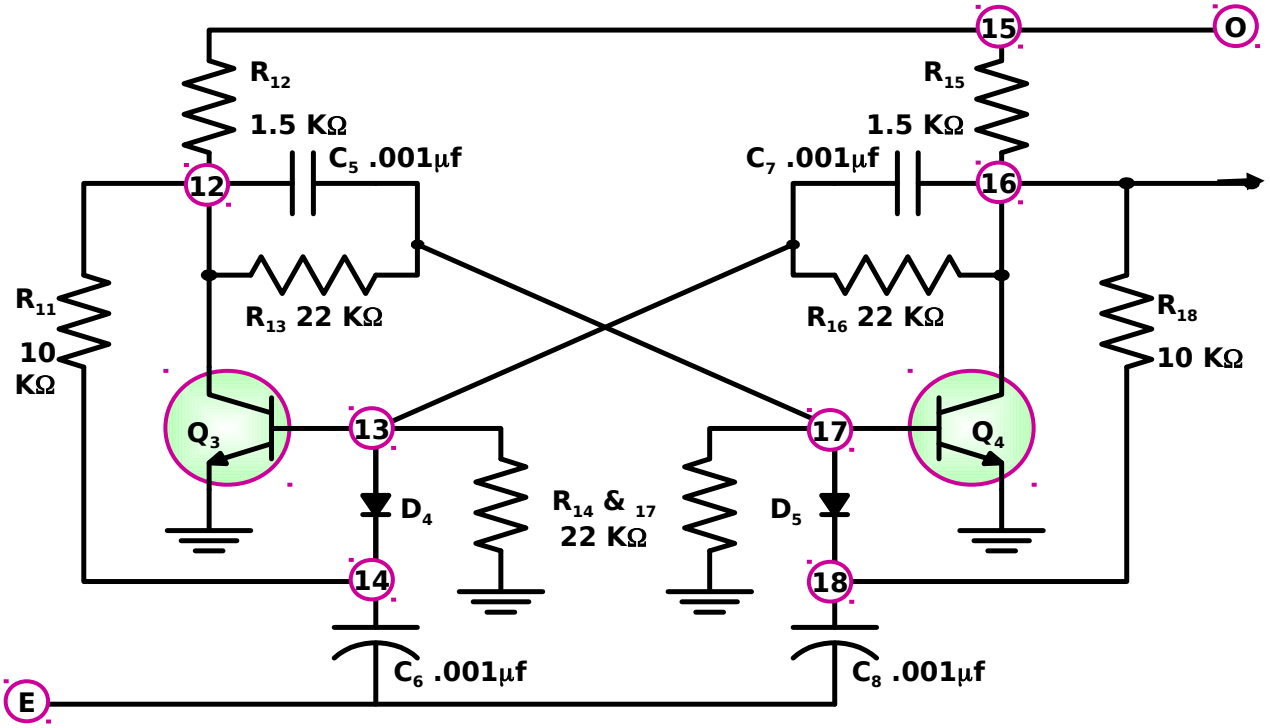


Mono Stable PC46: Ops, Triggered.



TIII: MULTIVIBRATORS

Bi Stable PC45: Circuits & Components.



BISTABLE:

2 stable states; Q3 on Q4 off, or Q4 on Q3 off.

R12 & 15; Collector Load Resistors.

R17 & 13; DC Base Bias for Q4.
R14 & 16; DC Base Bias for Q3.

C5 & 7; Quick Coupling Caps, Quick Change in conduction also enables Squaring of the waveform.

R11 & 18; Provides a means of biasing CR4 & 5.

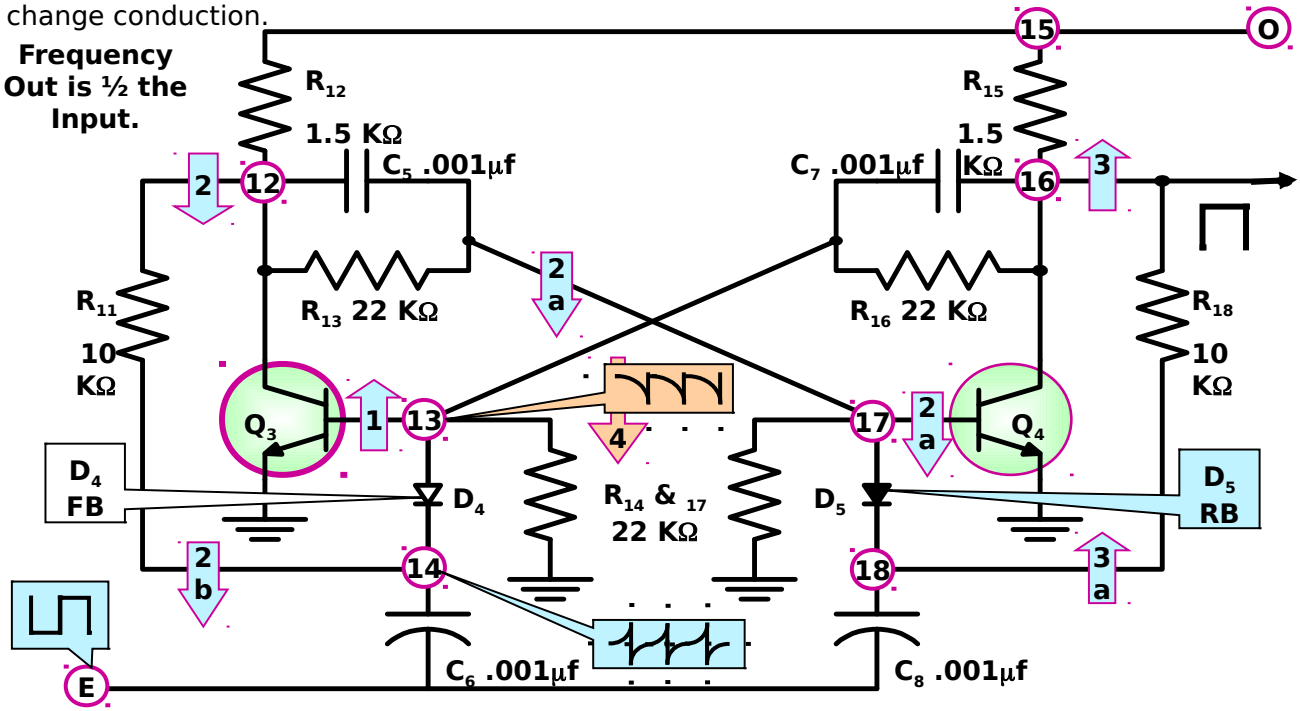
R11 & C6; Forms a Differentiator Ckt, in conjunction w/ CR4 enables the input trigger to change of state.
R18 & C8; Forms a Differentiator Ckt, in conjunction w/ CR5 enables the input trigger to change of state.

CR4 & CR5; Steering Diodes, [See previous 2 entry's] Allows Neg pulse to change conduction of Q4 or 3, only 1 is biased forward @ a time to allow the change of conduction to take place.

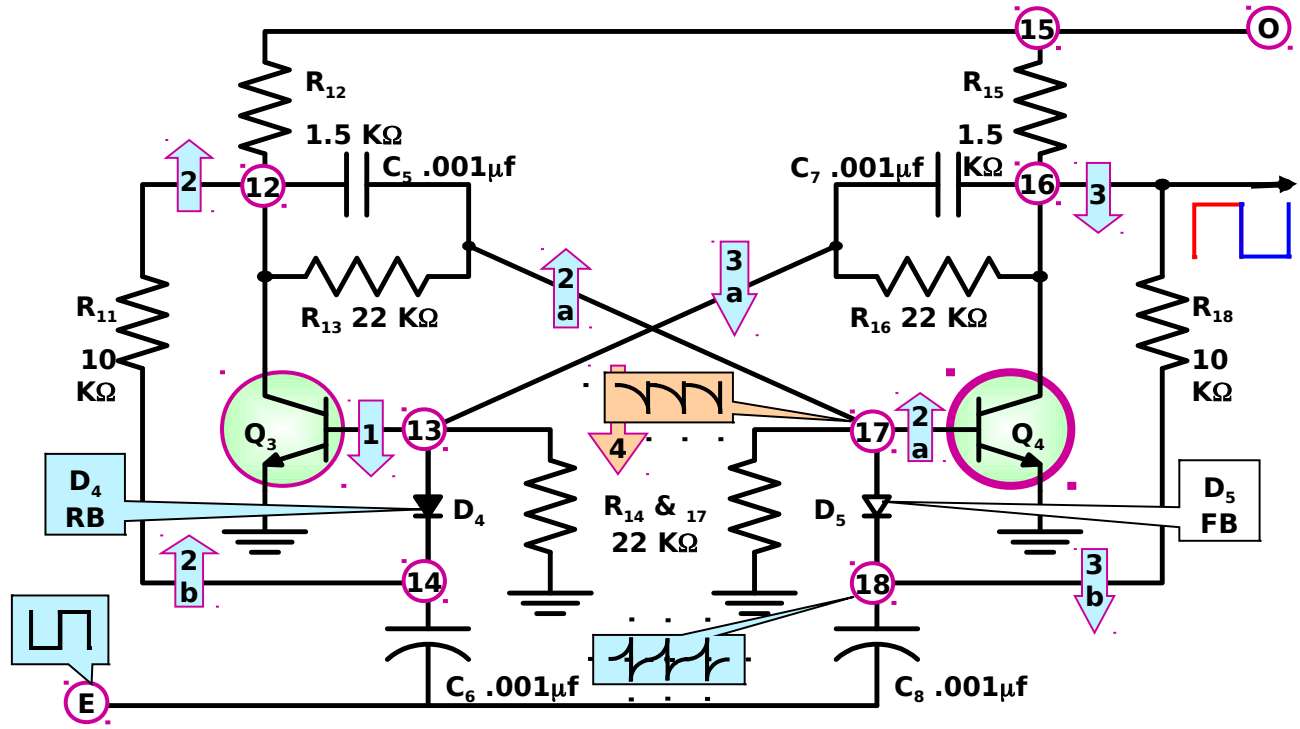
TIII: MULTIVIBRATORS

Bi Stable PC45: Ops, Q3 on Q4 off.

Stable State; Q3 On, Q4 C/O Remains in stable state until triggered. D4 FB allows trigger to change conduction.

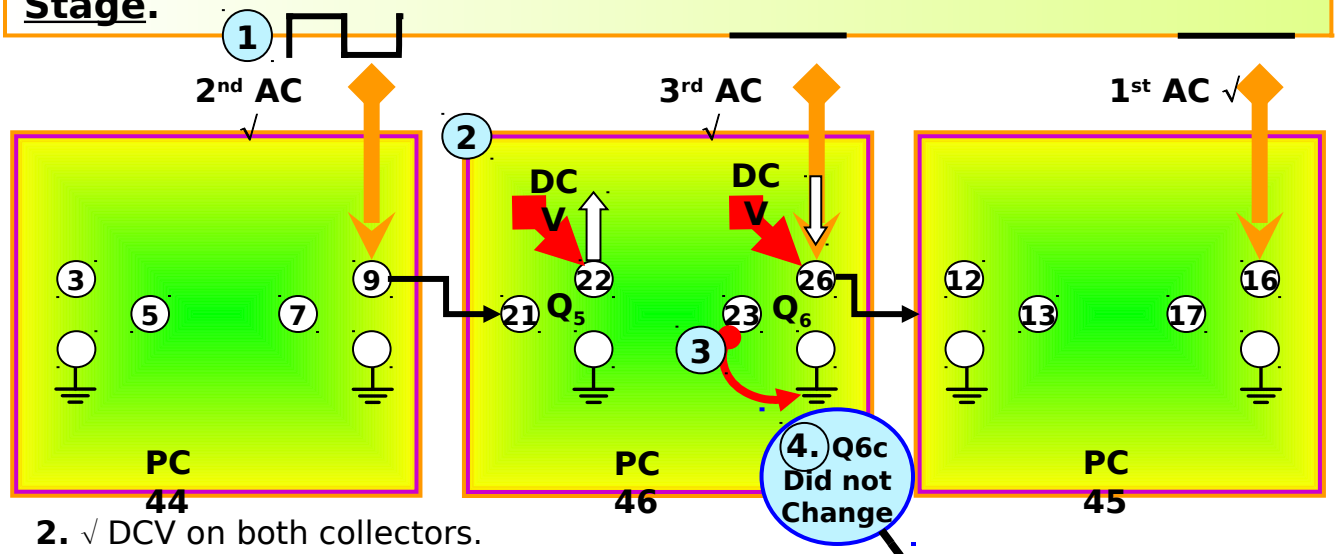


Bi Stable PC45: Ops, Q4 on Q3 off



TIII: MULTIVIBRATORS

Trouble Shoot: **PC 46 Defective Card. #1 Locate the Stage.**



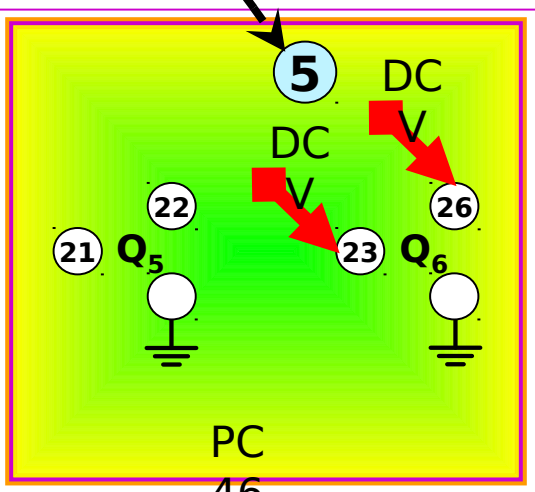
2. √ DCV on both collectors.

3. GND the Base of the transistor w/the lowest Collector Voltage.

4. Re √ DCV on both collectors, the collector that **Did Not Change** is the defective transistor Stage.

Ground Base Method

1. **AC √s , Locate Defective Card.**
2. **√ DCV on both Collectors.**
3. **Gnd the Base of the transistor w/the lowest collector voltage.**
4. **Re √ DCV on both collectors.**
5. **The Collector W/DCV that Did Not change, that stage is malfunctioning.**
6. **Remove the Gnd jumper from the Base.**
7. **Do Normal DCV √s & Ohms Confirmation.**



4. REMOVE Grounded Base Jumper Wire.

5. Do DCV √

6. Do Ohms confirmation √.

7. Record your results.

TIII: MULTIVIBRATORS

Review Questions:

1. What does the term “Astable” mean? _____
2. Which components determine the “OFF” time of Q1 on PC 44 card. _____
3. What type of output is produced by the Astable multivibrator?

   a. Sawtooth c. Squarewave

   b. Sinewave d. Differentiated waveform
4. Which components determine the output frequency of the Astable multivibrator. _____
5. What is the phase relationship of the signal @ TP3 to that of the signal @ TP9 of PC 44? _____
6. How many stable conditions does PC 46 have? _____
7. In the stable state, what are the conditions of Q5 and Q6? _____
8. What determines the output frequency of the Monostable multivibrator. _____
9. With C10 open, what is the condition of Q5 & Q6 ? _____
10. With the Positive Pulse applied, what is the condition of Q5 & Q6 ? _____
11. Which components determines the pulse width produced by PC 46 ? _____
12. The Bistable multivibrator has _____ stable states or conditions.
13. Diodes CR4 & 5 are called _____ _____ when used in the Bistable multivibrator.
14. What effect does the Bistable multivibrator circuit have on the input frequency? _____
15. In order for CR4 to be forward biased, what must be the condition of Q4 ? _____

TIII: MULTIVIBRATORS

Review Questions:

16. How many input triggers are required for one complete cycle of operation for PC45? _____

17. An Astable multivibrator is a form of _____

18 Refer to PC 44, what is the conduction level of Q1 & Q2 with Q2 Base open ? _____

19. What is the discharge path for C10 ? _____

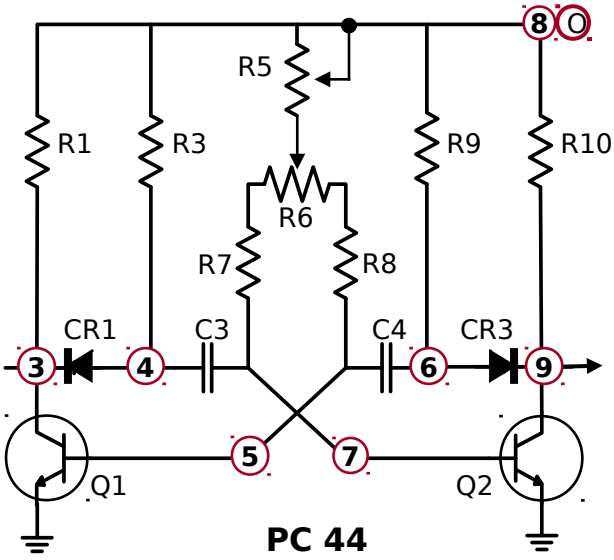
20. Refer to PC 45; what would be the indication if Q4 was shorted collector to emitter?

a. TP16 would be high

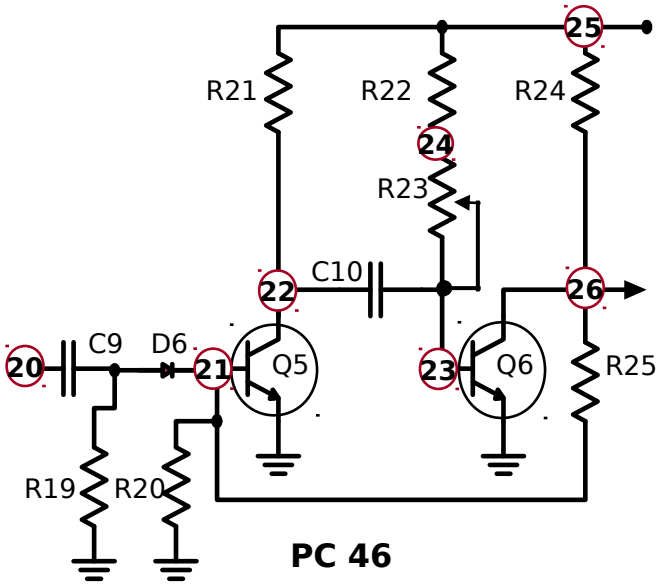
b. TP17 would be high

c. Q3 would saturate

d. CR5 would be reverse biased

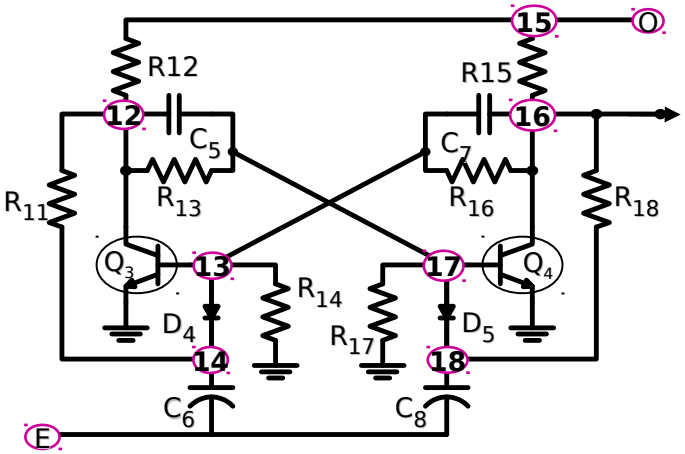


PC 44



PC 46

PC 45



TIII: MULTIVIBRATORS

PE Setup:

1. **PC 44** on PC 1 position

   PC 46 on PC 2 position

   PC 45 on PC 3 position

2. Set Trainer DC Volts to **12 VDC**

3. **PC 44;** Adj. **R6** for symmetrical Squarewave **@ TP9**.

   Adj. **R5** For Aprox. 2.2 KHz @ **TP9**.

4. **PC 46;** Adj. **R23** for Squarewave @ **TP26**.

5. **PC 45;** Output @ TP16 should be 1/2 the frequency of the input.

6. Get Normals

7. Shoot Bugs

F100	**F200**	**F302**
F102	**F202**	**F305**
F105	**F207**	**F306**
F106	**F210**	**F307**
F107		**F310**
F110		**F312**

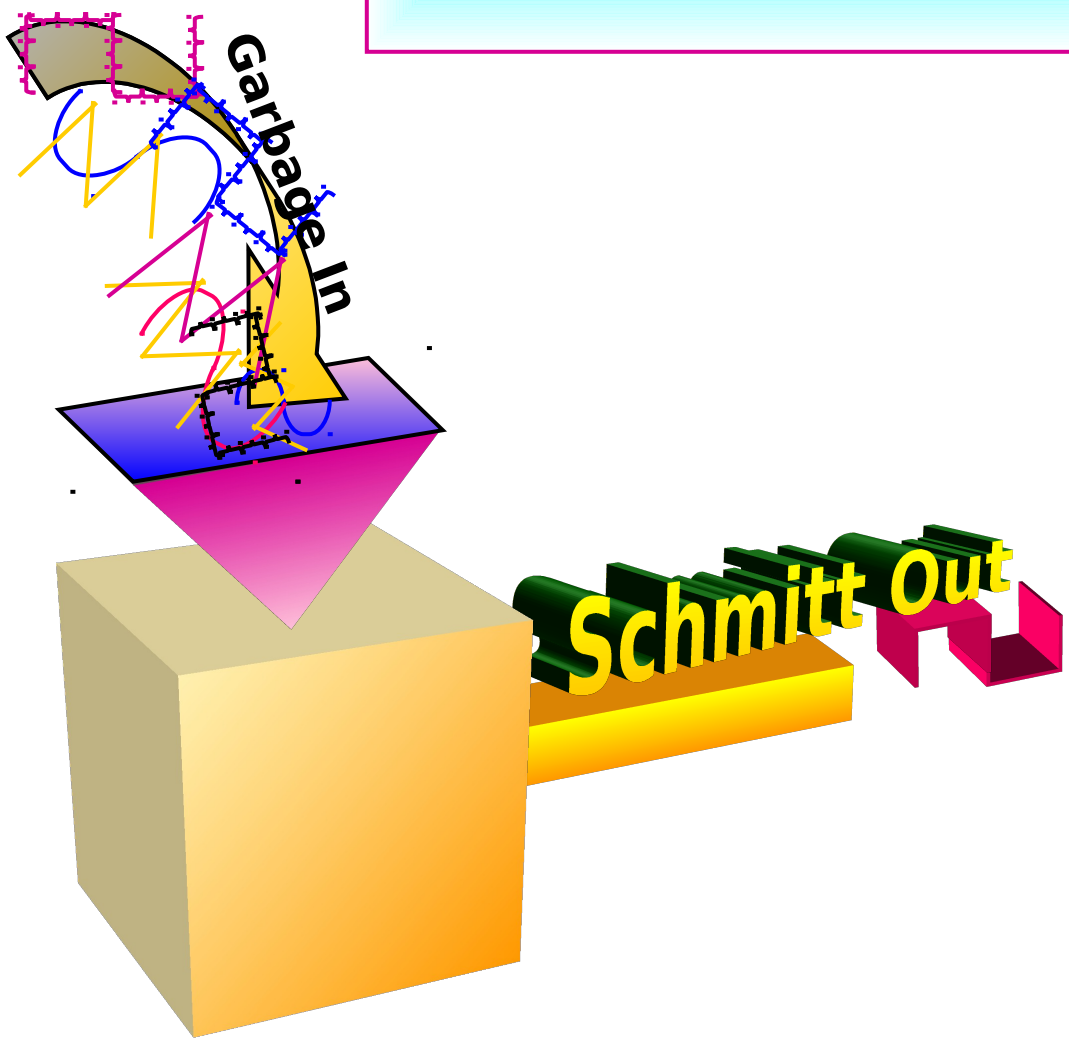
TIII:

Schmitt Trigger

Unclassified

2 Hour Conference, W/ 2 Hr PE1

Safety & Environmental Impact is "LOW"



TIII: Schmitt Trigger

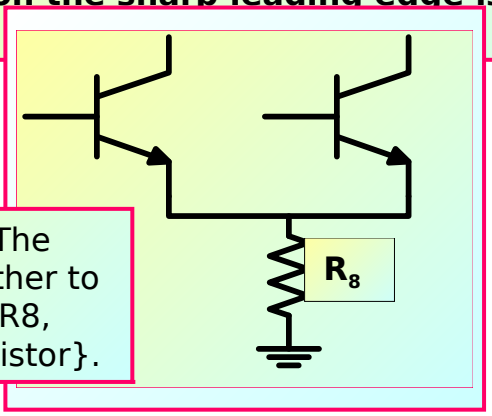
Schmitt Trigger Features;

Converts any input signal to a Squarewave, referred to as a squaring Ckt.

Used in waveform Restoration or Reformation.

Used for DC Level detection. [R2].

Rectangular output on the sharp leading edge is needed for precious timing.



Ckt recognition; The Emitters are tied together to a common resistor R8, {Emitter Feedback resistor}.

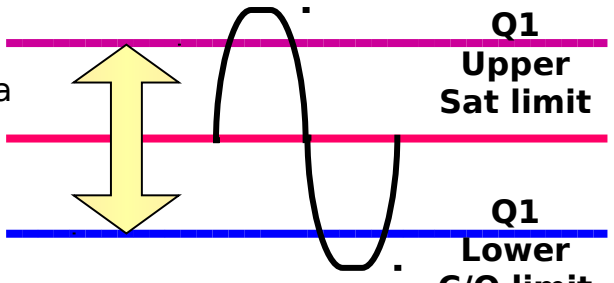
Schmitt Trigger Features; R2 DC level Detection.

Q1 & Q2 operates in extreme opposite states of conduction.

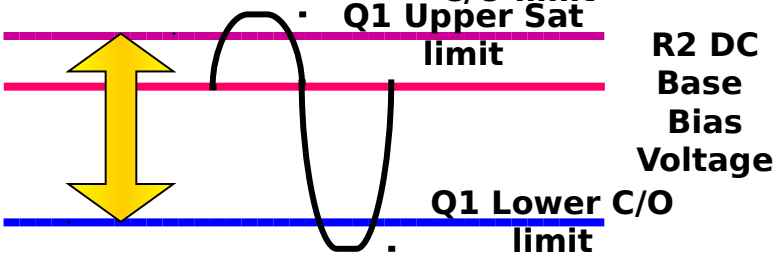
Q1 Saturated, Q2 in Cutoff, is the Static State, it remains in the static state until it is triggered by an external signal.

The time constant [TC] is dependent upon the DC level detection set by R2.

The transistor has a narrow difference from Saturation to Cutoff



By adjusting R2 sensitivity level higher Q1 saturate sooner thus allowing waveform reformation



TIII: Schmitt Trigger

PC42; Component ID.

R3, R2; _____

R4, R9; _____

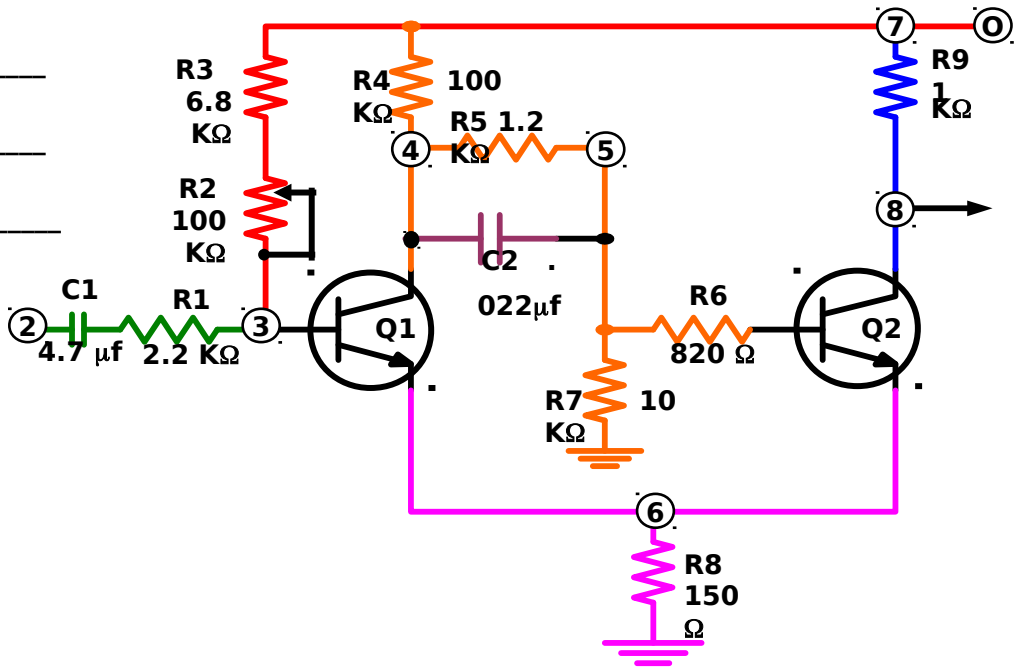
R4, 5, 6, 7; _____

R8; _____

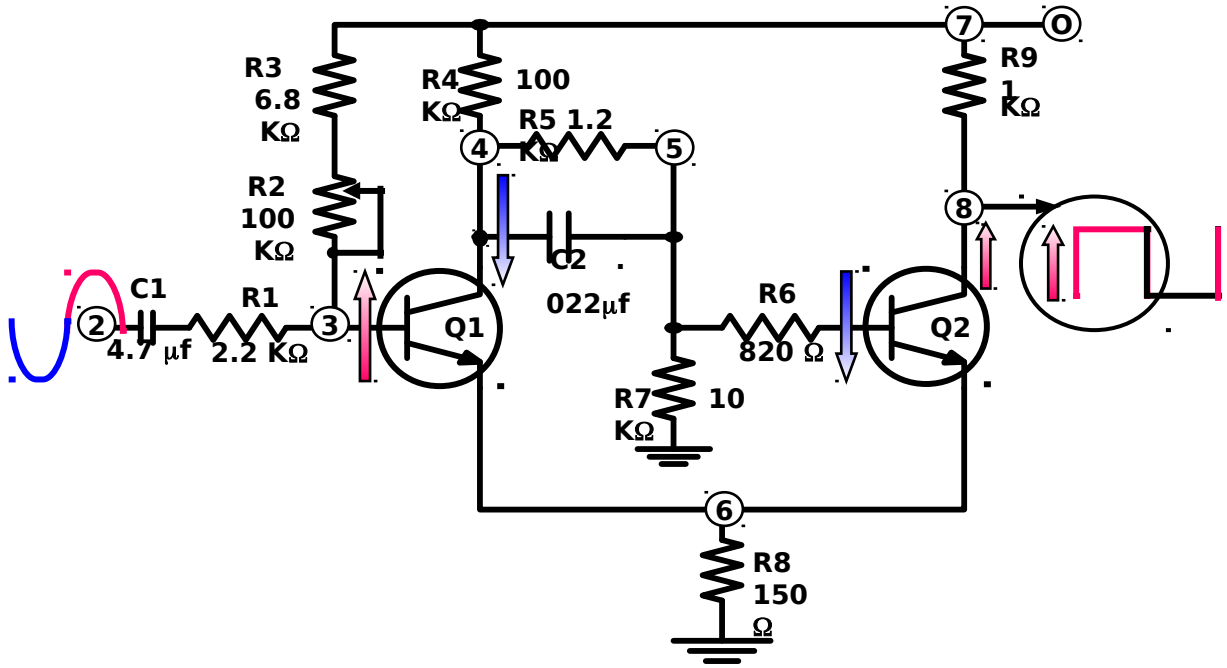
R1; _____

C2; _____

C1; _____

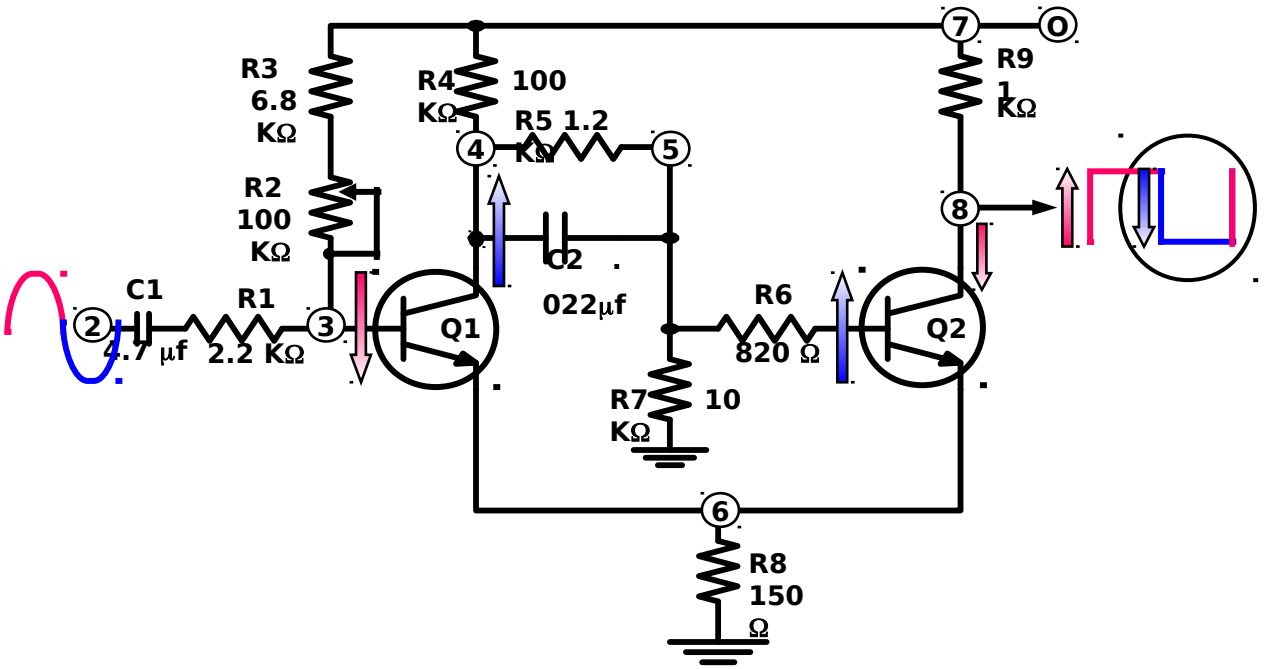


PC42; Ckt Operation, Static Mode & Positive Trigger.

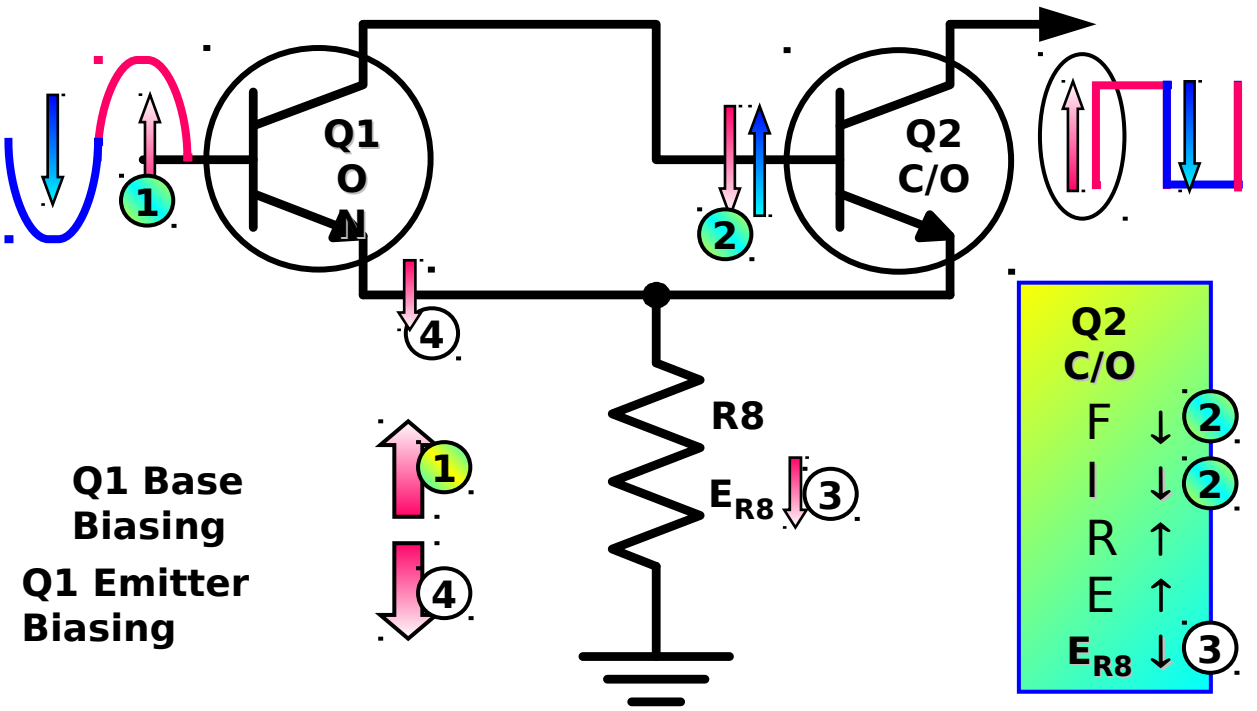


TIII: Schmitt Trigger

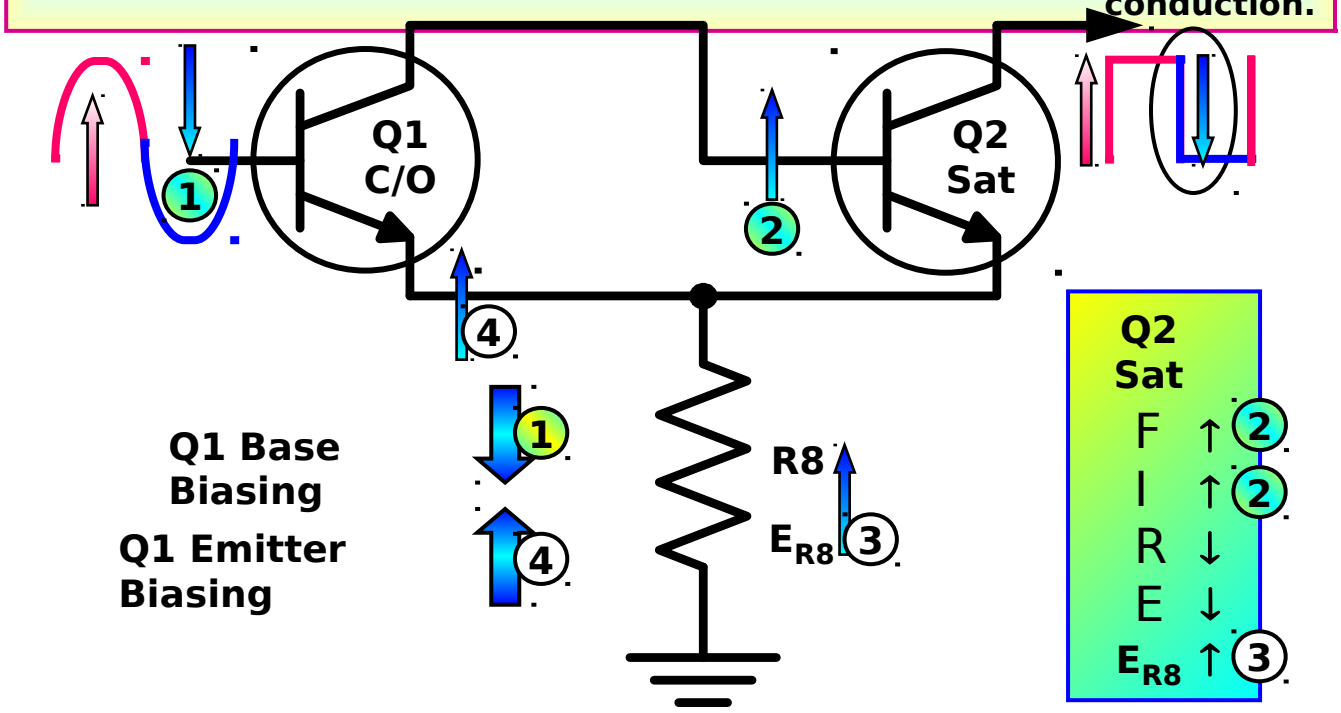
PC42; Ckt Operation, Negative Trigger.



PC42; Ckt Operation, Biasing, Q2 dictates a quick change of conduction.

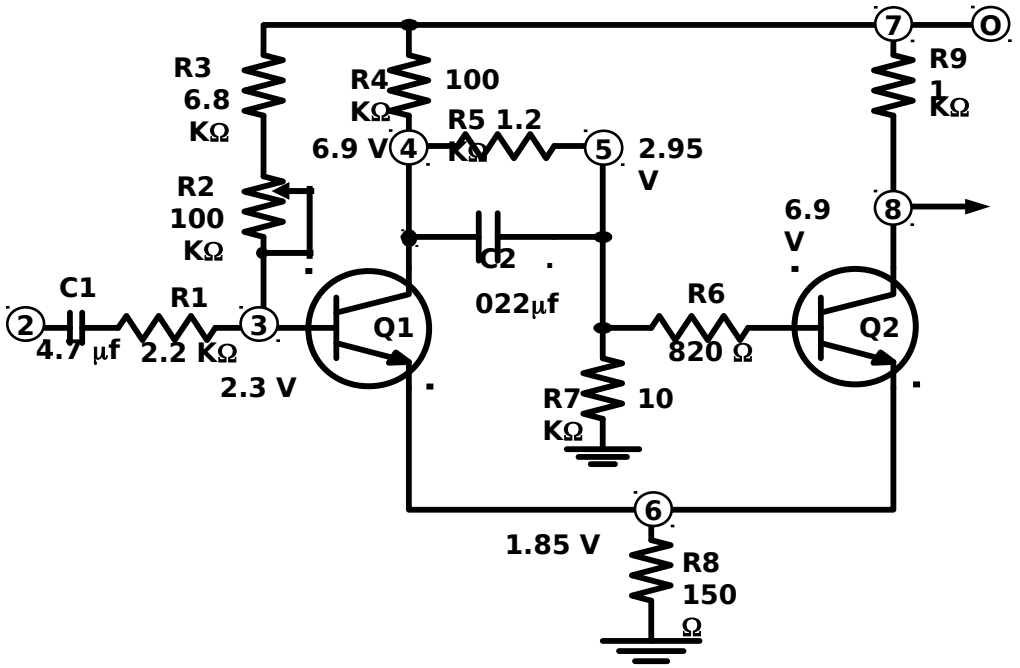


PC42; Ckt Operation, Biasing, Q2 dictates a quick change of conduction.



TIII: Schmitt Trigger

PC42; Troubleshooting.



Malfunction #1	Malfunction #2	Malfunction #3
TP8 ——	TP8 ——	TP8 ——
TP3 ∫	TP3 ∫	TP3 ∫
TP5 ——	TP5 ——	TP5 ~↓
TP4 ——	TP4 ——	TP4 ∫
TP4 10.8 V	TP4 8.6 V	TP8 2.6 V
TP3 10.69 V	TP3 0 V	TP5 2.75 V
TP6 10.61 V	TP6 1.92 V	TP6 2.6 V
Stage;_____	Stage;_____	Stage;_____
Componate;___	Componate;___	Componate;___
OPEN / SHORT	OPEN / SHORT	OPEN / SHORT

TIII: Schmitt Trigger

Review Questions; Refer to PC 47 for the following questions.

1. **A properly functioning Schmitt Trigger will always produce a _____ output.**
2. **What is one use for a Schmitt Trigger? _____**
3. **What open component would cause the collectors of both Q1 & Q2 to have a higher than normal voltage reading? {Both transistors going to cutoff} _____**
4. **What are the normal operating levels of Q1 & Q2 with no input signal applied? _____.**
5. **What is the purpose of variable resistor R2? _____**
6. **If 50 KHz waveform of sufficient amplitude to trigger a Schmitt Trigger is applied to its input, what output frequency will be produced? _____ .**
7. **As a negative alternation of the input signal falls below the bias level set by R2, Q1 will { Conduct / Cutoff } _____**

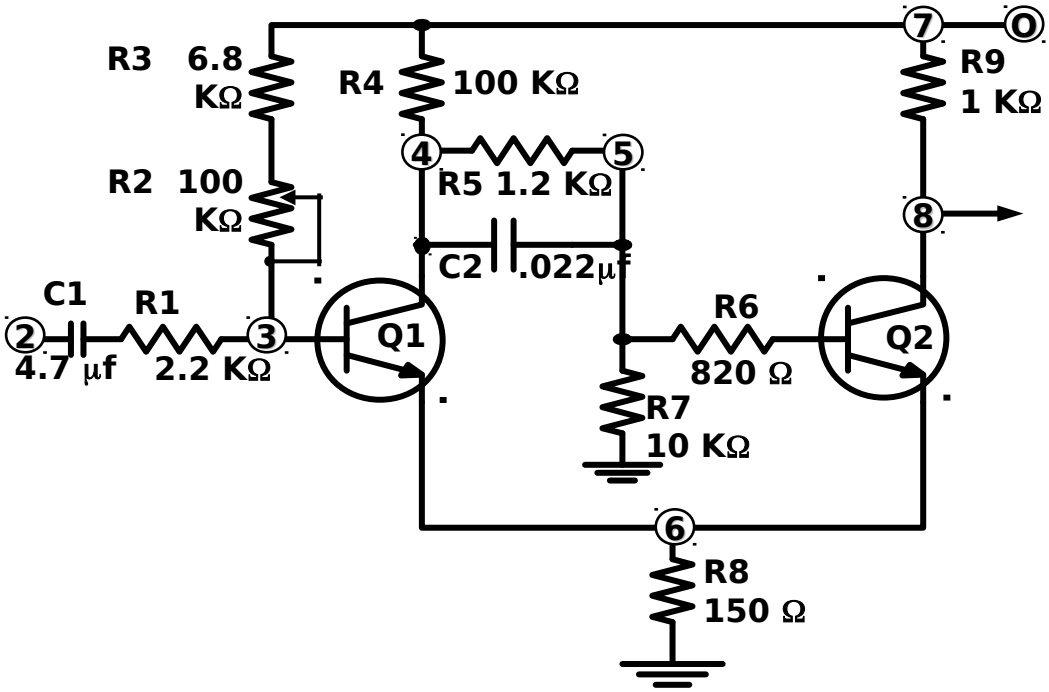
TIII: Schmitt Trigger

Review Questions; Refer to PC 47 for the following questions.

8. **Circuits that provide the reshaping of signals are often called _____ .**

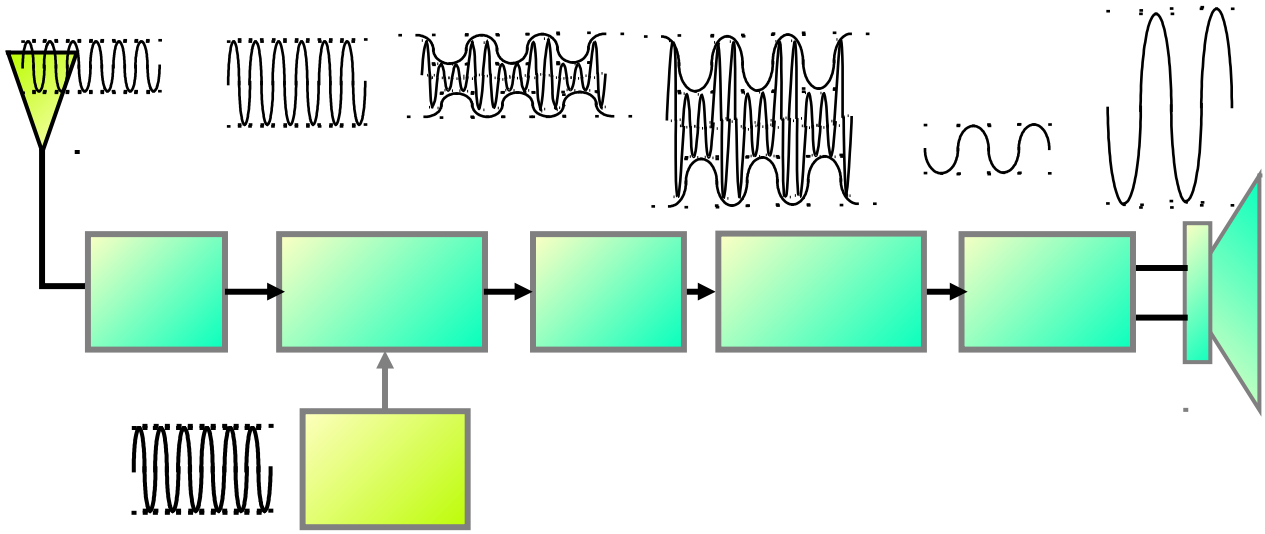
9. **What is the purpose of C2? _____ .**

10. **There is no output, input is good and there is an amplified signal @ TP4, TP8 = 12V, TP5 = Normal. What is a possible Malfunction? _____**



SUPERHETERODYNE RECEIVER

Unclassified
4 Hour Conference, W/ 7Hr PE1
Safety & Environmental Impact is "LOW"



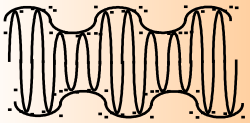
All electronic communications both in defense as well as the private sector are centered around the very basic transmitter & receiver groups.

This lesson will concentrate on the Receiver group w/ an overview in a block diagram of the transmitter group.

TIII: SUPERHETERODYNE RECEIVER

Overview;

AM; Amplitude Modulated



WLW Cincinnati OH.

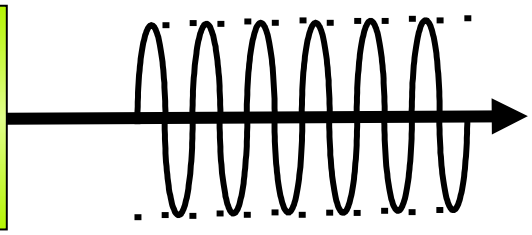
KLT Pittsburg Pa.

The FCC, Federal Communications Commission grants all License, & call letter designations. 3 call letter stations were grandfathered in due to there existence before the establishment of the FCC in 1932.

FM; Frequency Modulated

TRANSMITTER GROUP; OSCILLATOR

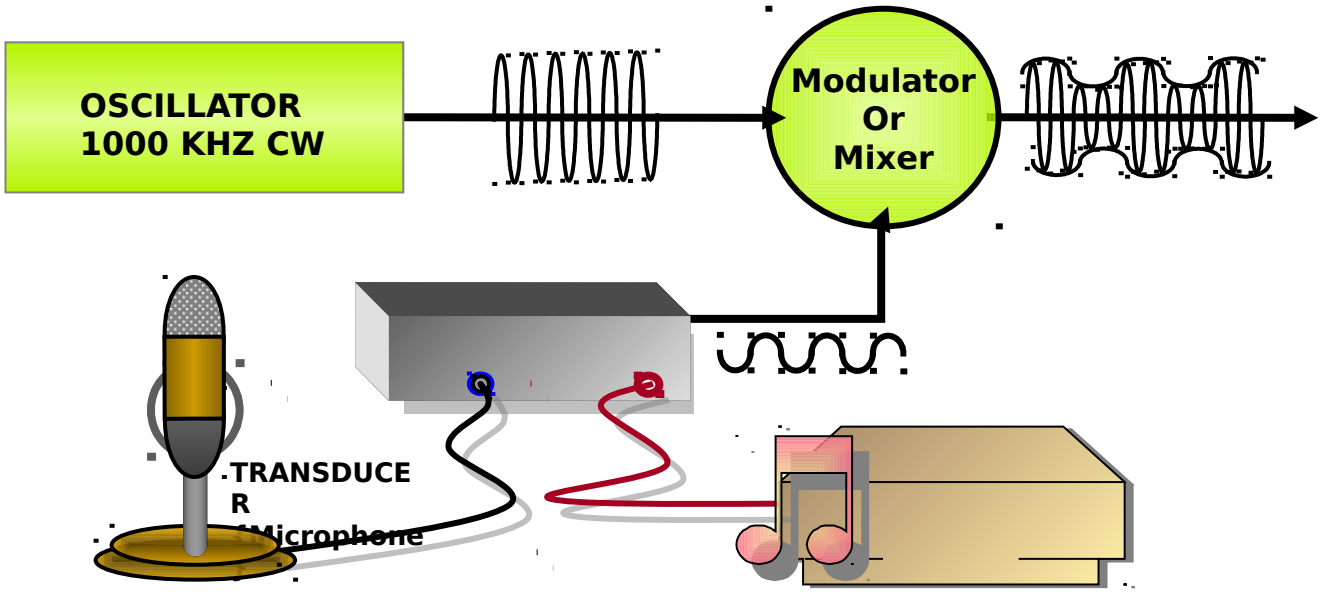
OSCILLATOR 1000 KHZ CW



TRANSMITTER – Generates a continuous wave (CW) carrier frequency with an additional signal intelligence impressed upon it, thus becoming an Amplitude Modulated (AM) signal. Once powered up the AM signal is put on the air as transmission RF waves via an antenna.

TIII: SUPERHETERODYNE RECEIVER

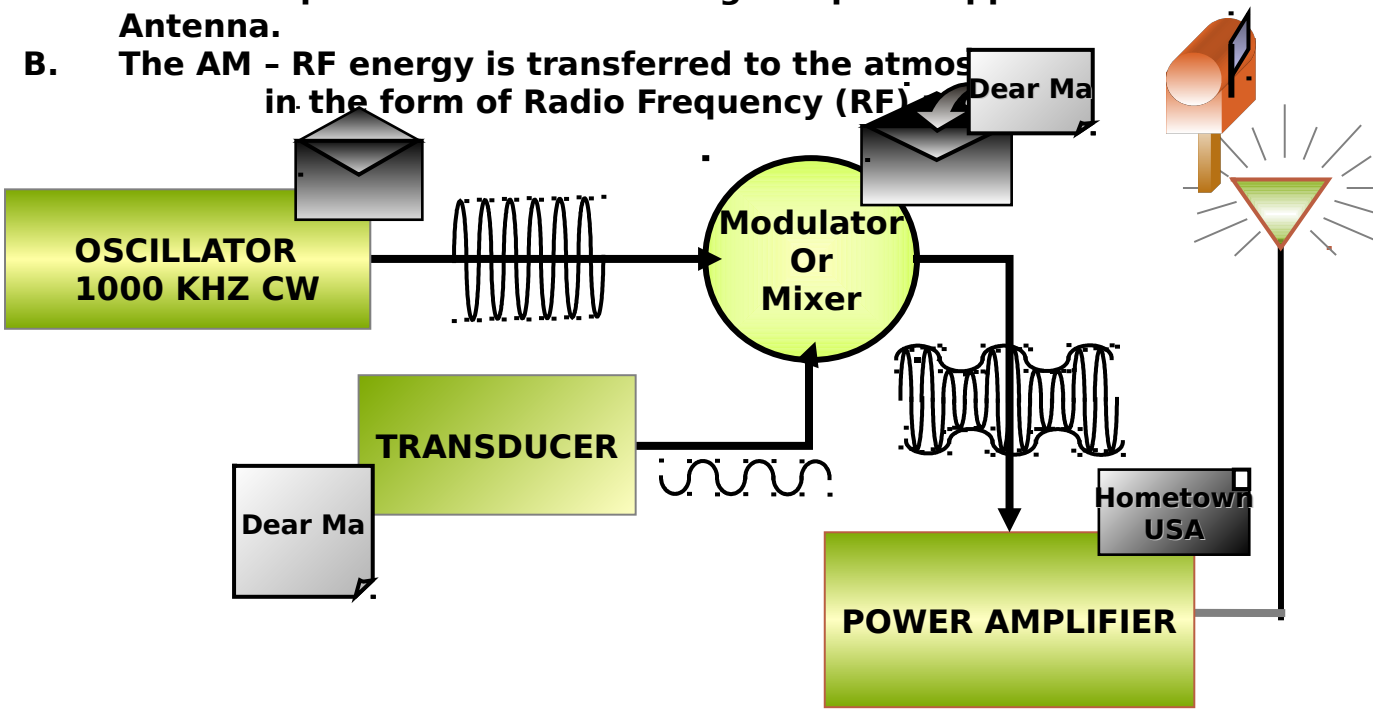
TRANSMITTER GROUP; MODULATOR



A. Input acquired from OSCILLATOR (1000 KHZ)
B. A 2nd signal from transducer is mixed with 1000 CW to produce and Amplitude Modulated (AM) signal or Carrier Transmission.

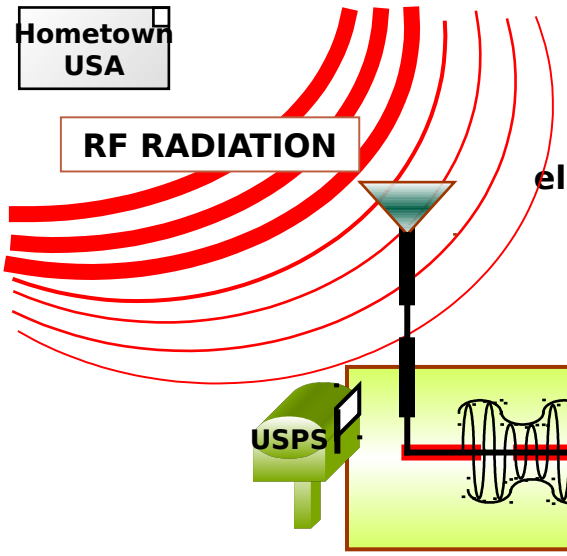
TRANSMITTER GROUP; POWER AMPLIFIER

A. Power Amplifier Boosts the AM signal up and applies it to the Antenna.
B. The AM – RF energy is transferred to the atmos
in the form of Radio Frequency (RF)



TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; Antenna



Antenna (aerial)

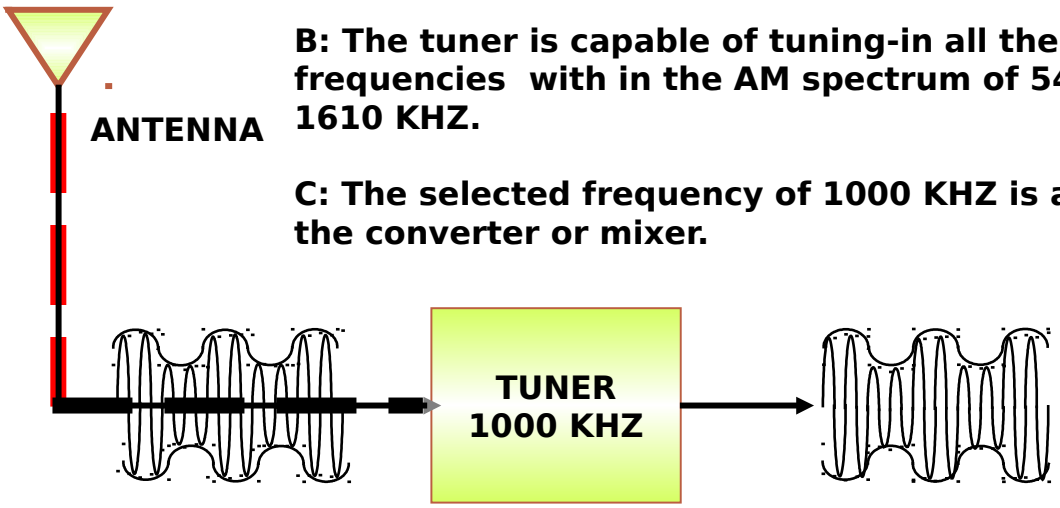
Is the device that intercepts the AM electromagnetic radiation waves. As the waves pass and are cut by the aerial, small amounts of current will be induced upon it.

RECEIVER GROUP; TUNER

A: Selects one signal from the many on the aerial by tuning a Parallel LC Tank circuit to resonate @ 1000 KHZ.

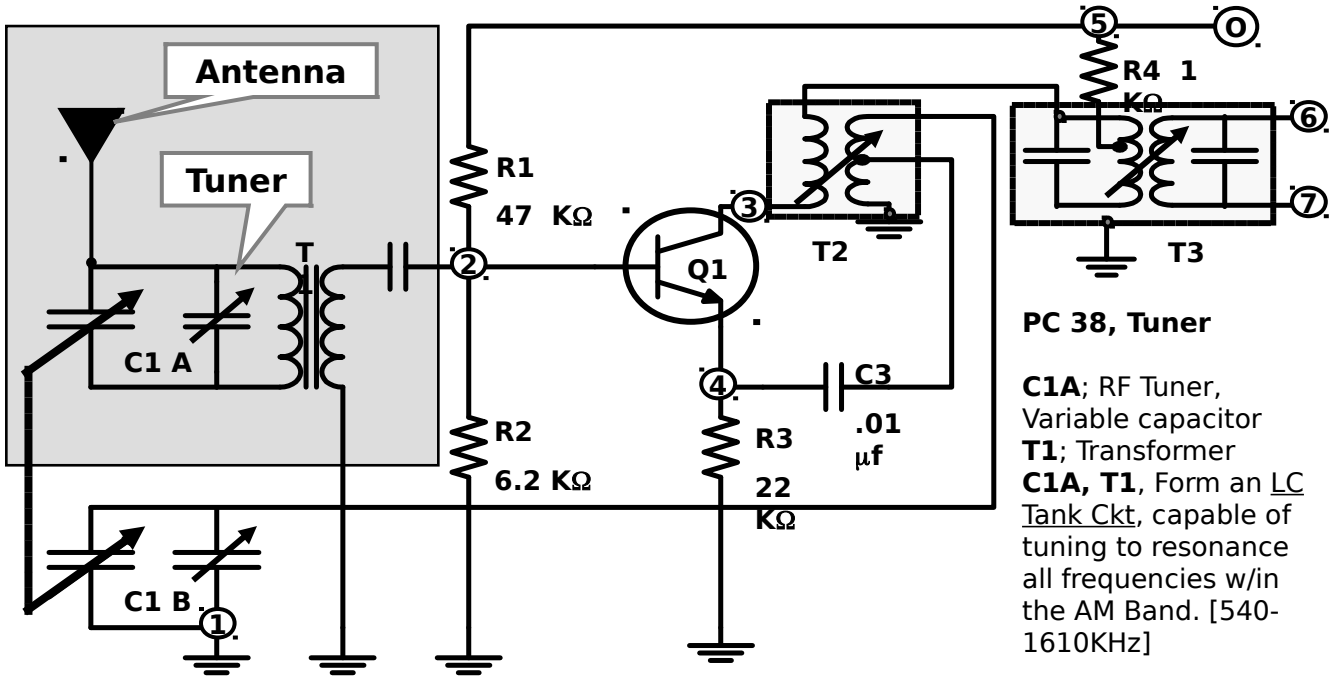
B: The tuner is capable of tuning-in all the AM frequencies with in the AM spectrum of 540 KHZ – 1610 KHZ.

C: The selected frequency of 1000 KHZ is applied to the converter or mixer.



TIII: SUPERHETERODYNE RECEIVER

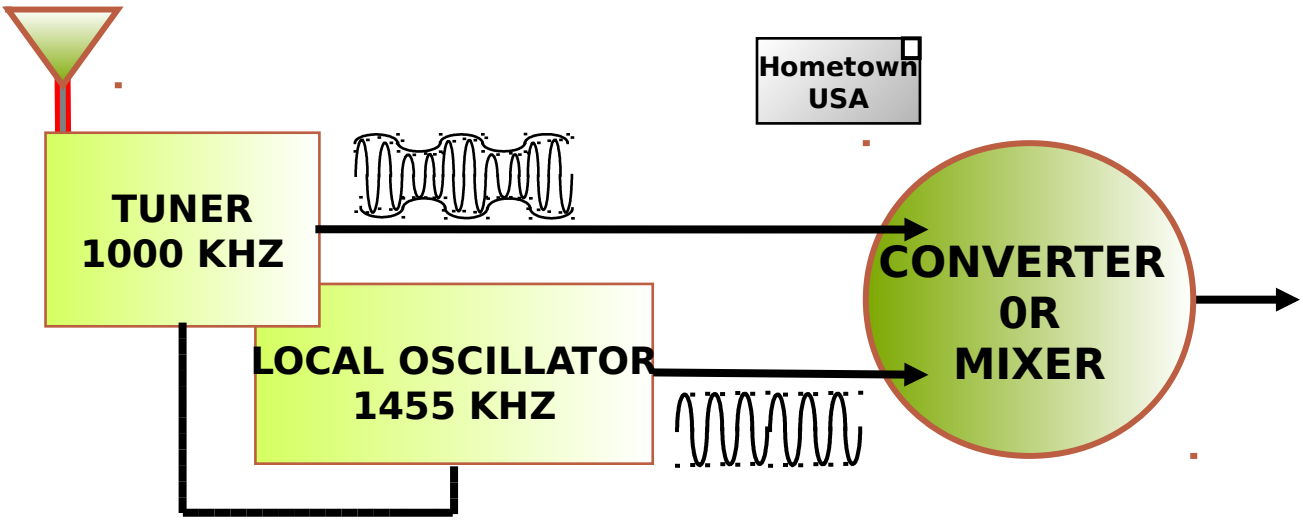
RECEIVER GROUP; PC 38. Antenna & Tuner.



PC 38, Tuner

C1A; RF Tuner, Variable capacitor
T1; Transformer
C1A, T1, Form an LC Tank Ckt, capable of tuning to resonance all frequencies w/in the AM Band. [540-1610KHz]

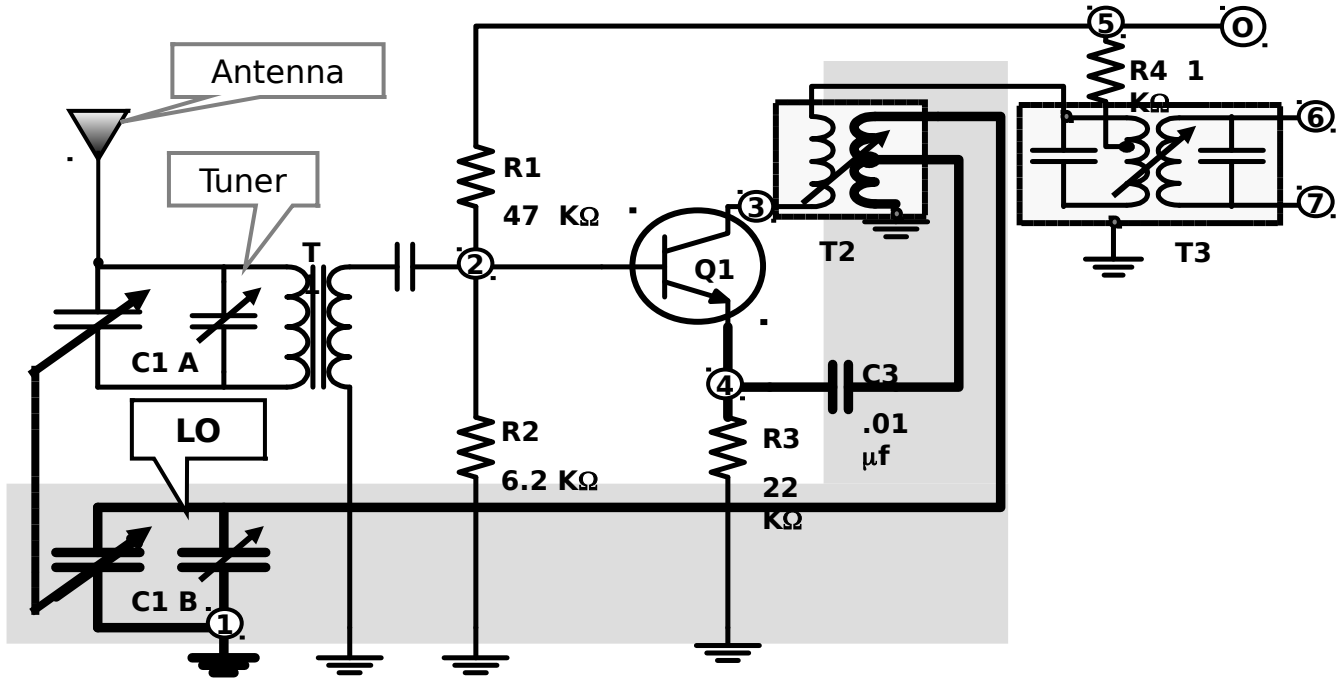
RECEIVER GROUP; Local Oscillator [LO]



1. The LO Signal output is always the Tuner Frequency, Plus 455 KHz Regardless of what AM signal is tuned.
2. It is tuned simultaneously with the RF Tuner.
3. The output would be 1000 + 455 = 1455 KHZ CW.
4. The output of 1455 KHZ is sent to the Converter or Mixer.

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; PC 38, Local Oscillator [LO]



PC 38 Local Oscillator:

C1B; Variable Cap, Tunes in unison W/ C1a to produce the same freq of the tuner cap + 455 KHz. Mechanically & physically linked W/Variable Tuner Cap**.**

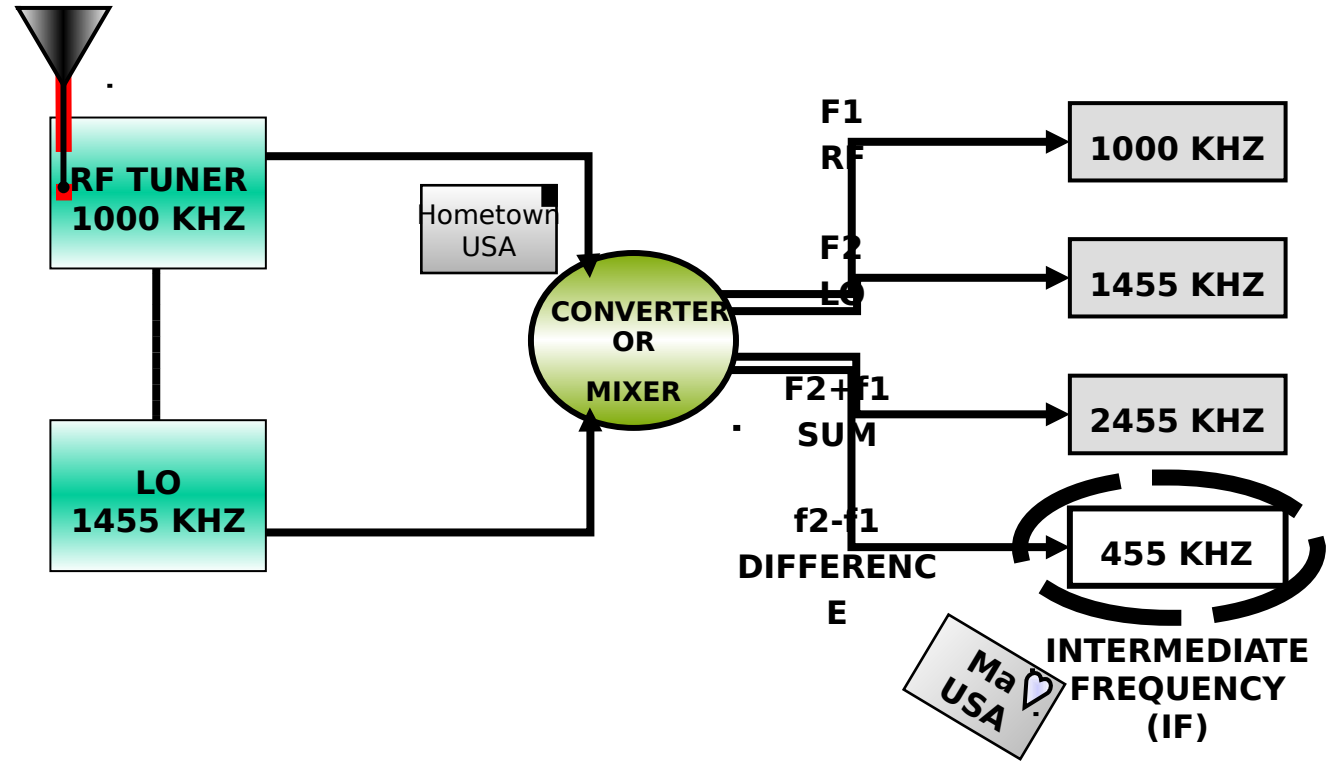
T2 primary; W/ C1B form a LC Tank CKT**.**

C3; Coupling cap to Q1 Emitter, Works in unison W/ R3 To form a RC Coupler.

Note; Q1 acts like a CB Amp for the LO, Where as the Tuner is applied to the base is acting like a CE Amp**.**

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP;Converter / Mixer



Converter [Mixer]:

This where the process of Heterodyning takes place**.**
The 1000 KHZ from the Tuner is heterodyned with a 2nd signal from the Local Oscillator [1455 KHz] to produce 4 different output frequencies.

F1; RF Tuner Frequency [1000 KHz]
F2; LO Frequency [1455 KHz]
F3; The Sum of the Tuner + LO [2455 KHz].
F4; The Difference of F1 & F2 [455KHz].

The F4 or Difference is known as the **[IF] Intermediate Frequency.**

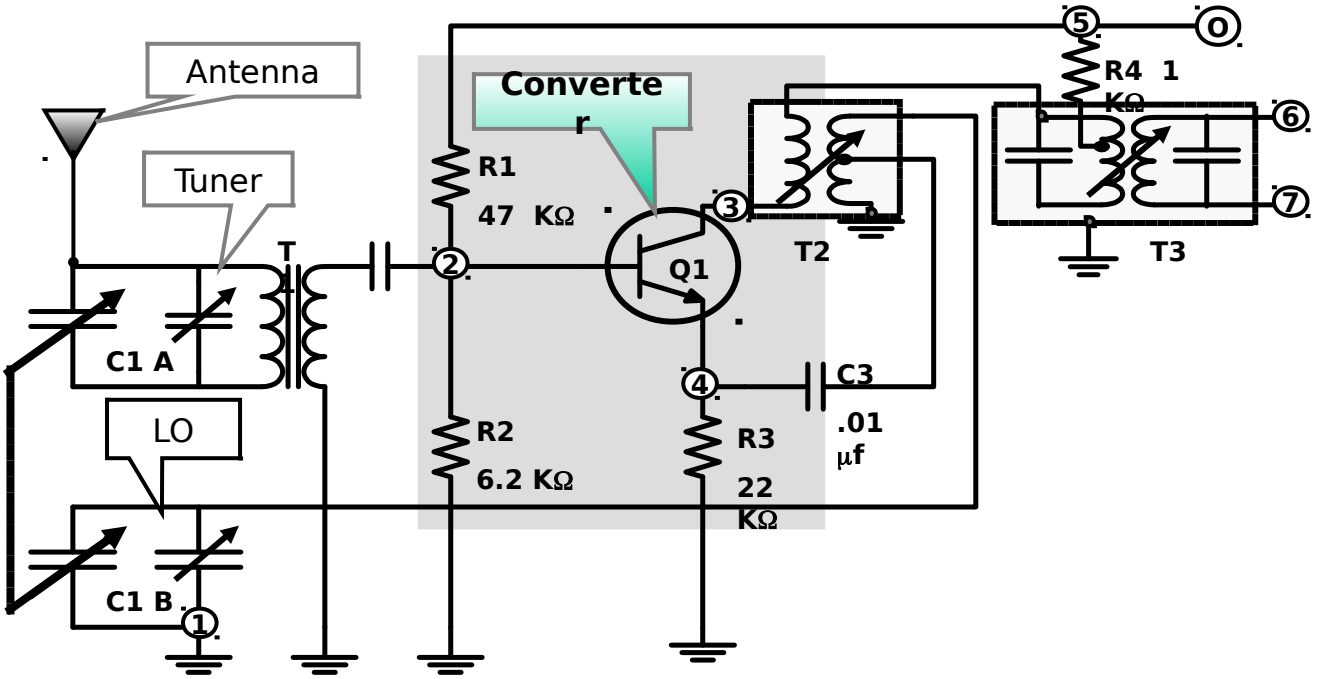
Regardless of the station tuned the out put for an AM receiver Converter will always be 455 KHz.
This allows for uniformity and selectivity across the entire AM bandwidth.
All Ckts from this point are tuned to pass only 455KHz AM.

The IF is sent to the IF amplifier.

The mail has been sorted, and has a specific address sent out for delivery by a new carrier.

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; PC 38 Converter / Mixer



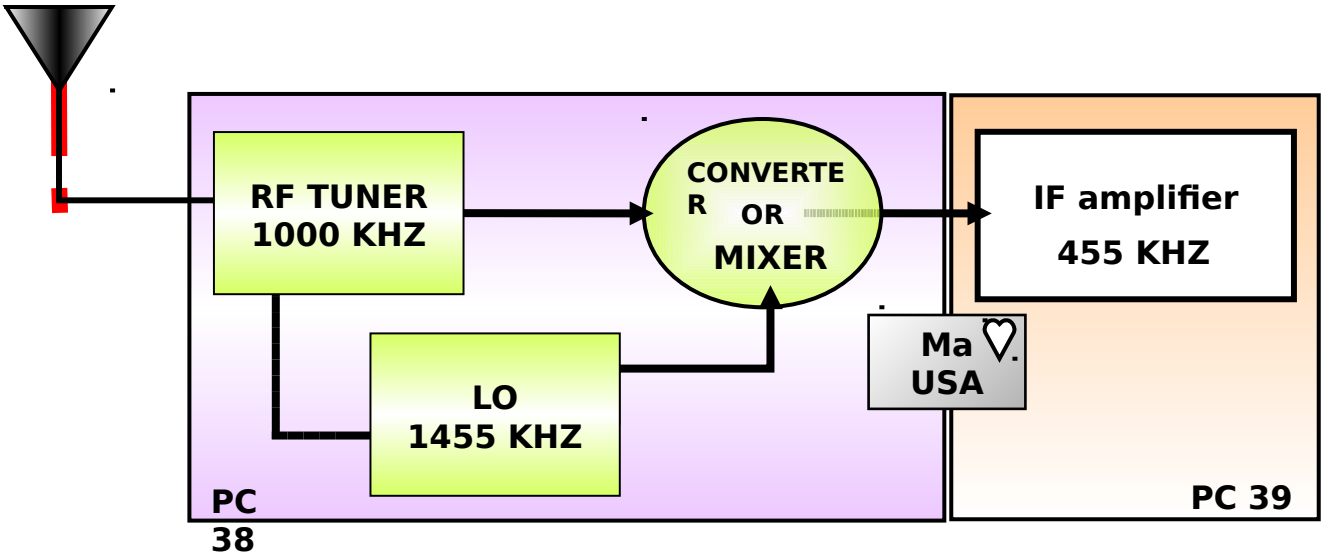
PC 38, Converter

Q1: Acts like a CB Amp for the LO, Where as the Tuner is applied to the base is acting like a CE Amp**.** The Output is take @ the Collector.
R3; Emitter DC Bias, Work W/ C3 as an input coupler For the LO.
R1 &2; DC Base Bias For Q1. R2 Works W/ C2 as an input coupler for the tuner.

T2; IF Transformer, Sensitivity & Selectively Tuned to pass 455 KHz.
T3, 4, 5, Are aligned & Calibrated to the tuned frequency of 455 KHz W/ a Bandwidth of 10 KHz.
T2 secondary; Acts as an inductor, to ensure complete waveform development & prevent PWR loss.

T3; Couples signal to the IF Amp, Impendence Match & tuned for The IF. [Transformer Coupling]
R4; Allows for a Potential to be felt on the Center tap of T3.

RECEIVER GROUP; IF Amplifier



IF AMPLIFIERS:

Intermediate Frequency (IF).
IF amplifier has the most receiver gain and is made up of 2 cascaded high gain amplifiers tuned to 455 KHZ.

Sensitivity and bandwidth [T4 & 5] are determined by this stage.

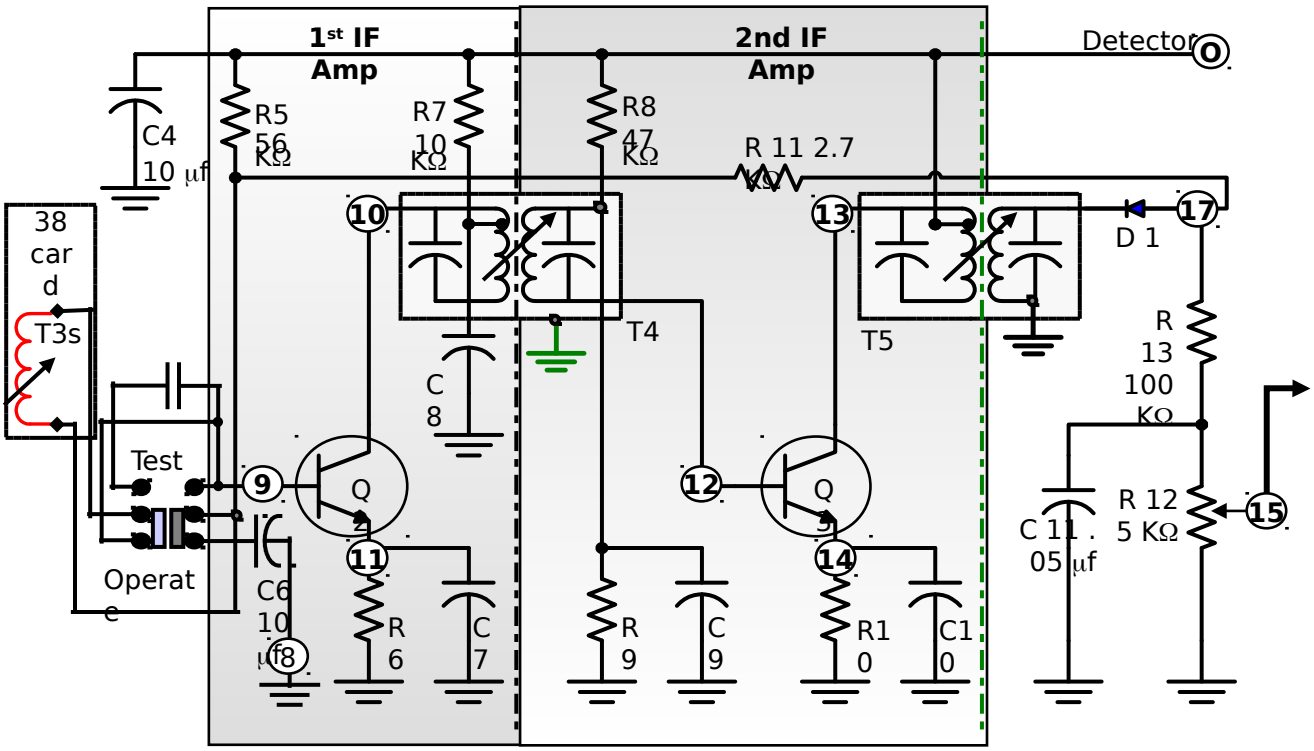
(IF) will allow for uniform selectivity across the entire receiver tuner spectrum.
Regardless of frequency or station, the IF will be 455 KHZ Amplitude Modulated
All the circuits of the IF Amplifier are tuned to 455 KHZ

Selectivity is the ability of IF amplifiers to select only one frequency and amplify it.

The [IF] output is sent to the detector (demodulator).

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; PC 39 IF Amplifiers



PC 39, IF Amplifiers:

1st Stage;

Q2; CE Amp, **R6;** Emitter Bias resistor. **C7;** Degeneration cap.
R5; DC Base Bias.
R7; DC Collector bias for Q2, thru Center Tap of T4p. **C8;** Removes signal development across R7
T4p; IF transformer tuned to pass 455 KHz, Transformer Coupler from Q2 to Q3.

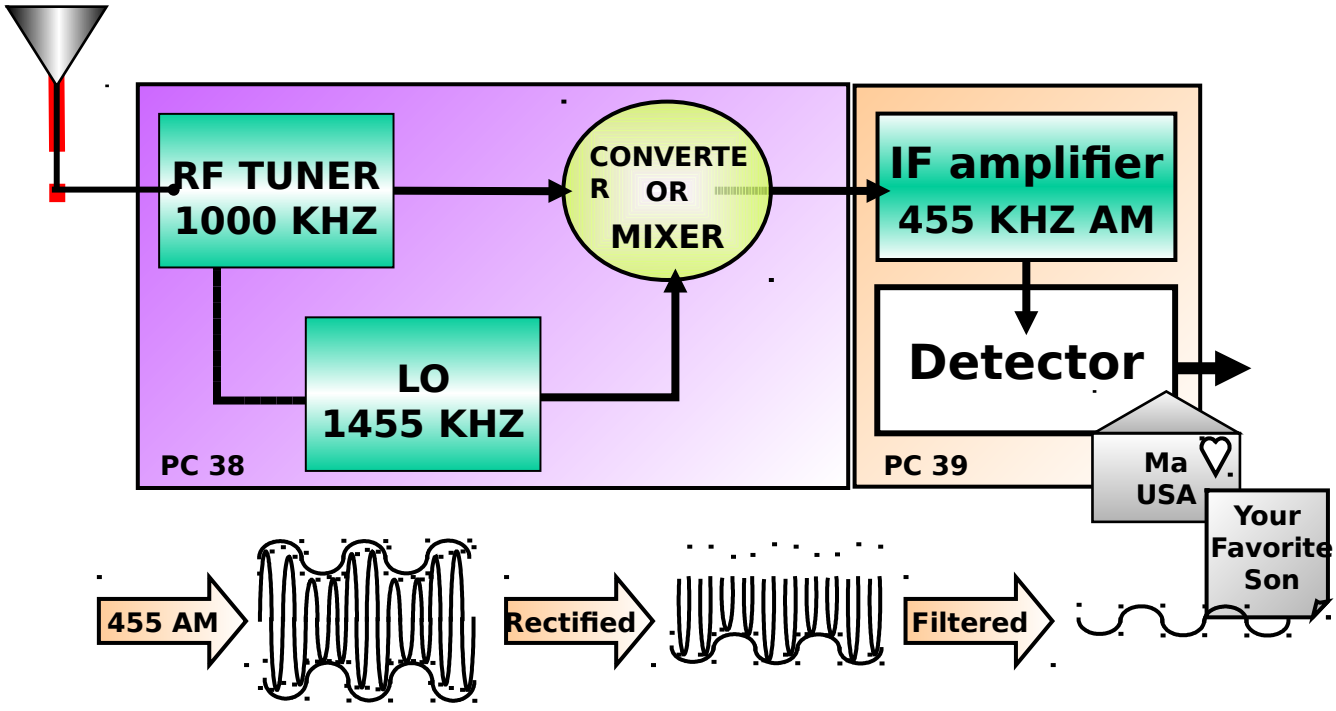
2nd Stage;

Q3; CE Amp, **R10;** Emitter Bias resistor. **C10;** Degeneration cap.
R8 & 9; DC Base Bias thru T4s. **C9;** Removes any extraneous signal development inT4s Coupling process.
T4s; IF transformer tuned to pass 455 KHz, Transformer Coupler from Q2 to Q3.
T5p; IF transformer tuned to pass 455 KHz, Transformer Coupler from Q3 to D1 Detector Ckt. Also Center Taped for DC Collector Bias.

C4; Swamping Cap, shunts any developing signal to ground, protects DC Pwr supply from AC interference.

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; DETECTOR OR DEMODULATOR



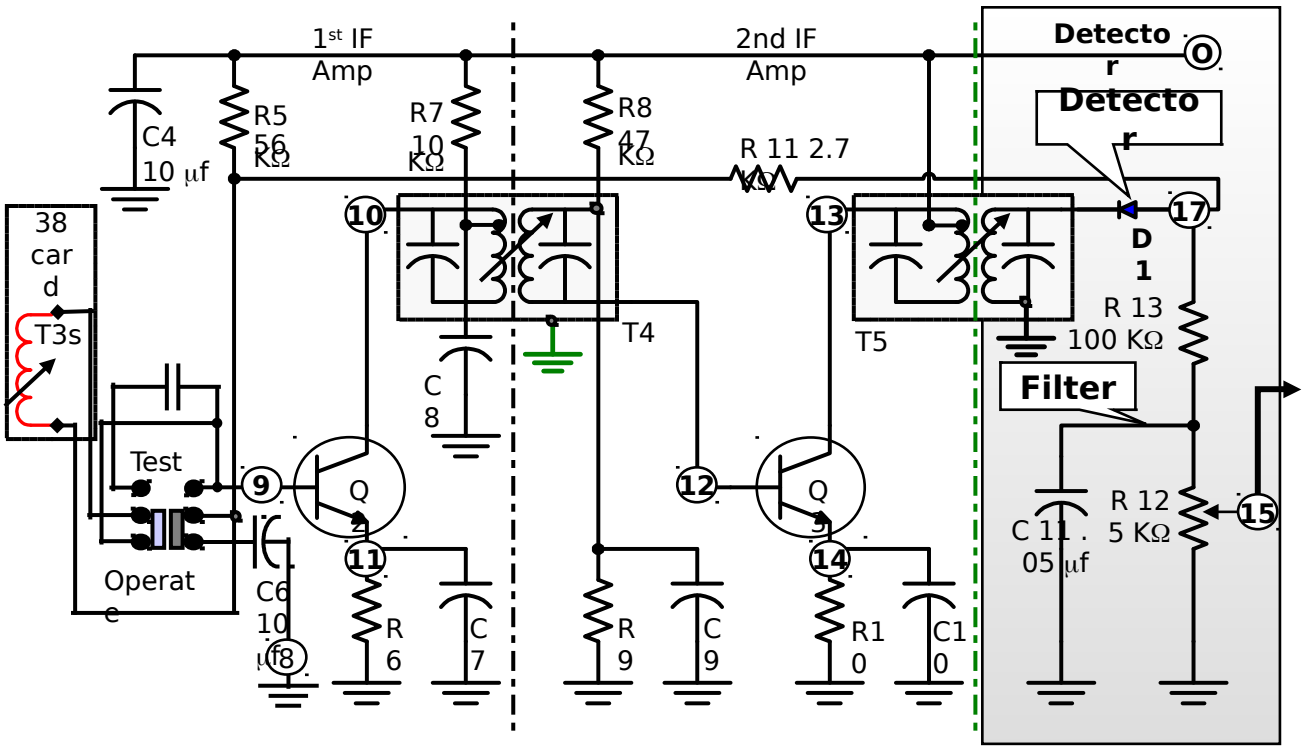
Detector / Demodulator:

Rectifies the modulated signal,
then filters it of the 455 KHz
Leaving only the audio frequency or intelligence of 50 Hz – 20 KHz
Which is sent to the AF amplifiers.

Mail is Delivered; MA opens the letter by removing it from the carrier [envelope], Removes the Intelligence & Reads [Filters]

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; PC 39 DETECTOR OR DEMODULATOR



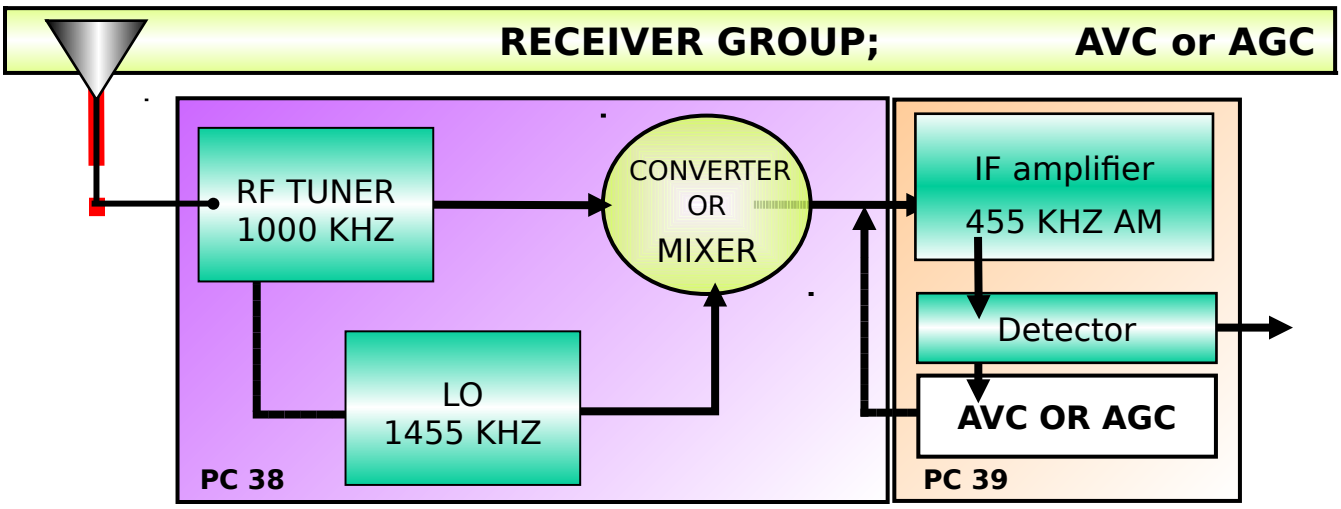
DETECTOR / Demodulator:

D1 [CR1]; Demodulator crystal, set to forward Bias on the [Cathode] Negative portion of the signal, [Signal is Rectified] R12, 13, 11, &5 DC voltage divider, allows positive Biasing to be felt on Anode of Cr1 increasing its sensitivity to very small fluctuations in the signal.

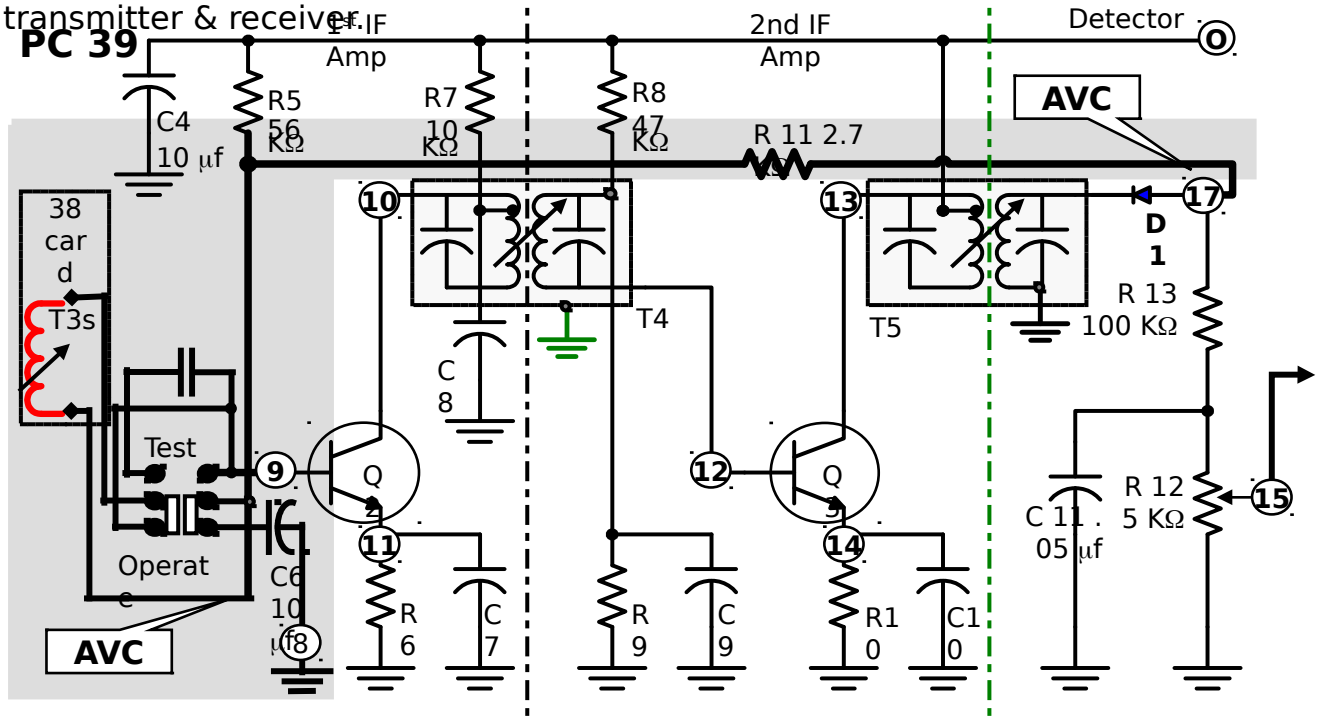
C11 & R12; Filter, strips the rectified signal of the 455 KHz Carrier, acts as a Time Constant filter, canceling out the IF, Leaving the AF, Audio Frequency.

R12; potentiometer, Volume control; TP15, 1st signal injection point in trouble shooting.

TIII: SUPERHETERODYNE RECEIVER



Automatic Volume Control or gain control is taken at the detector (demodulated and fed back to the first IF amplifier base. Required to overcome atmospheric and terrain conditions that adversely affect signal strength between the transmitter & receiver.



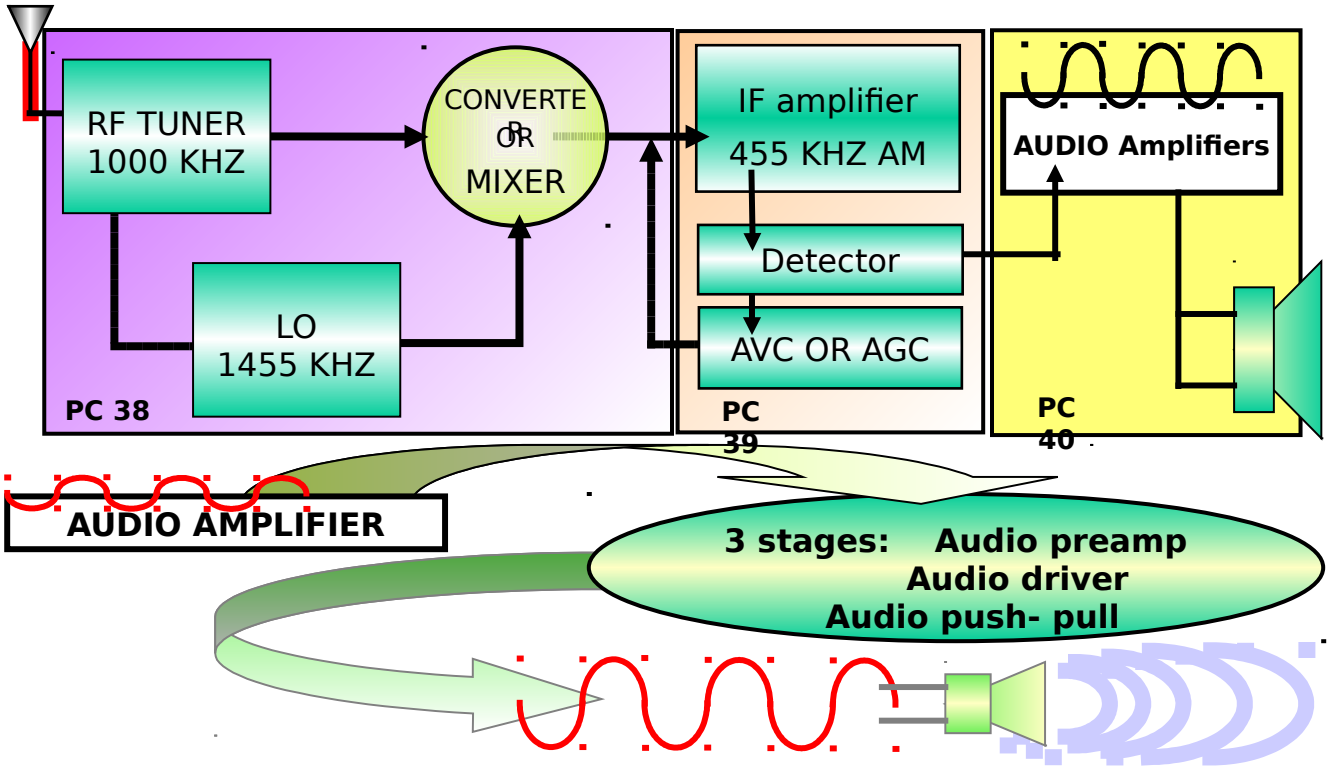
Automatic Volume or Gain Control: AVC / AGC

Signal amplitude Sample signal taken @ D1 [CR1] Felt thru R11, PC38; T3s, Test / Operate Switch, to Base of Q2. Sometimes referred to as feedback.

C6; Is charged to the Average DC in the AVC control path. This allows short duration changes in the signal, from changing Q2 bias. Other words only allows major changes in signal strength to effect Q2 base Biasing.

TIII: SUPERHETERODYNE RECEIVER

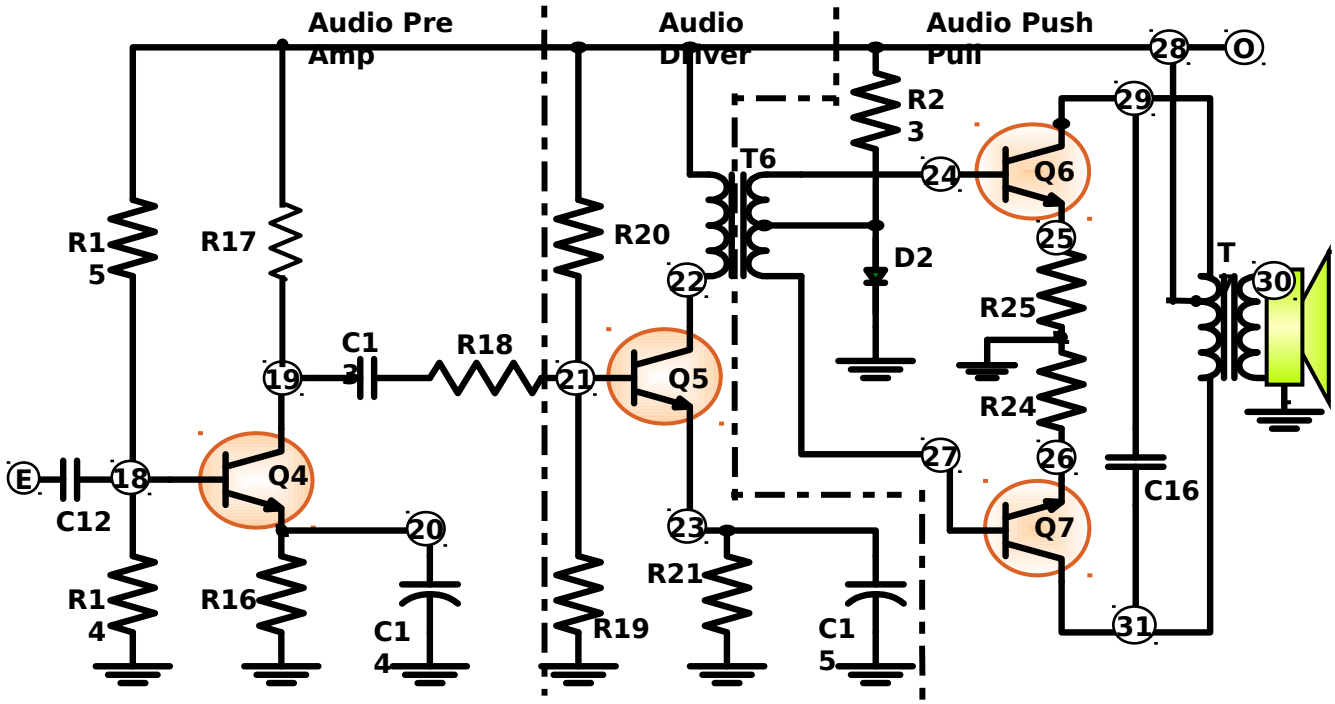
RECEIVER GROUP; AUDIO AMPLIFIER



The AF Intelligence from the Detector Ckt, is amplified and transferred w/ enough Power to drive the Output transducer [Speaker].

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; PC 40, AUDIO AMPLIFIER

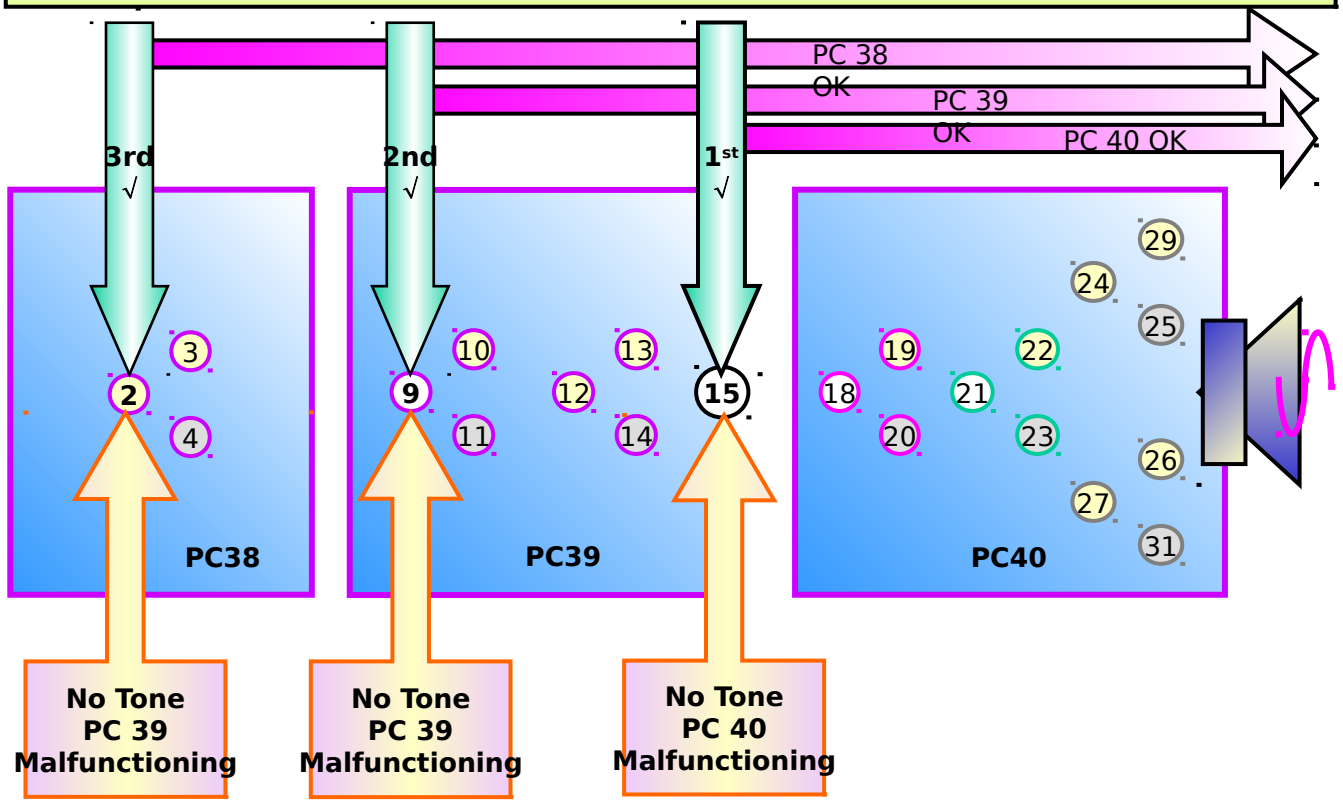


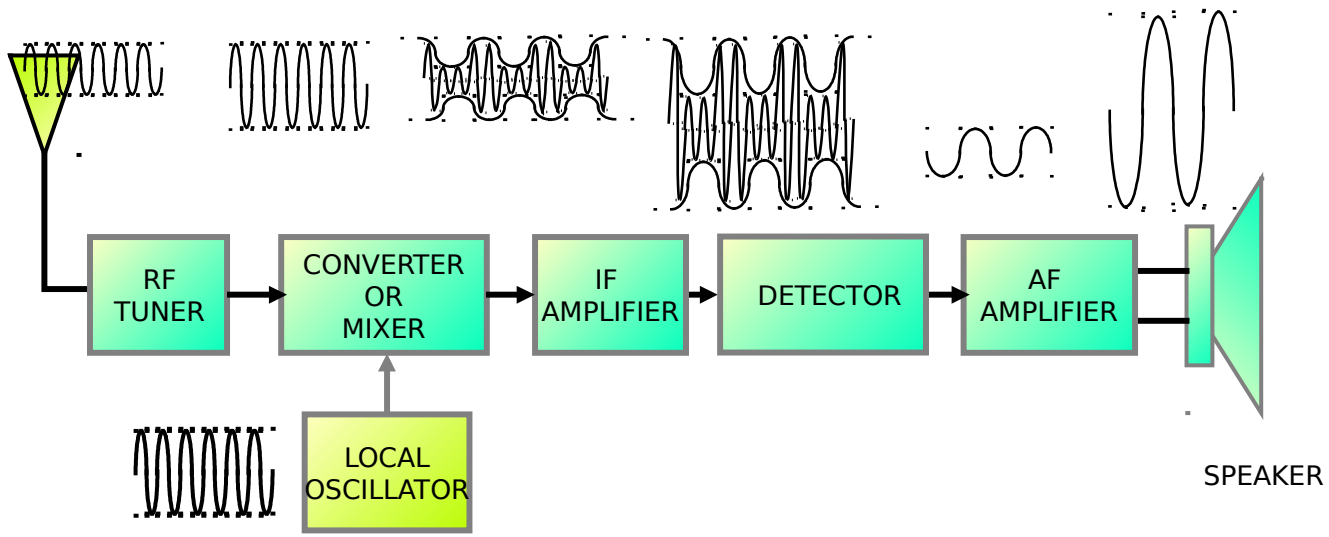
PC 40, Audio Amp:

Audio Pre Amp;
Q4; Common Emitter Amp, NPN.
R14 & 15; DC Base Biasing for Q4.
R16, DC Emitter Biasing. **C14;** Prevents Signal Degeneration, **R17;** DC collector Bias, W/**C13;** output coupler from Q4 to Q5.
R18, In series W/C13 to prevent overdriving of Q5 Bias, thus distort the signal.
Audio Driver Amp; Provides sufficient driving Pwr to the Push Pull
Q5; Common Emitter Amp, NPN.
R19 & 20; DC Base Biasing for Q5
R21, DC Emitter Biasing. **C15;** Prevents Signal Degeneration, **T6p;** allows for near EA on collector Q5.
T6; Audio Transformer, Center taped allowing 2 voltages of the same amplitude but opposite in polarity. Impedance matched & coupling from Q5 to Q6 & 7 Push Pull.
Audio Push Pull Amp; Biased on to prevent Crossover Distortion By D2, Operates In opposite states of conduction.
Q6 & 7; Common Emitter Amps, NPN.
R23 & D2; DC Base Biasing for Q6 & 7, through T6s, **D2;** Allows 600mV to be felt on the bases of Q6 & 7.
R25 & 24, DC Emitter Biasing. **C16;** Prevents Noise & Static,
T7; Audio Transformer, Step down, Center taped primary balances the output of Q6 & 7. Impedance matched between the amp & Speaker.

TIII: SUPERHETERODYNE RECEIVER

RECEIVER GROUP; Trouble shooting procedure.





TIII: SUPERHETERODYNE RECEIVER

Review Questions;

1. **Where does heterodyning take place in the receiver taught?**
   _____
2. **The IF amplifier is tuned to the _____ frequency of _____ KHz.**
3. **What are the block diagram stages of a Super heterodyne receiver?**
   _____ _____ _____
   _____ _____ _____
   _____ _____
4. **What components make up the Local Oscillator & Feedback? ___, ____, ____.**
5. **What is the propose of the AVC [AGC] Ckt in the receiver?**
   _____
6. **What are the two actions needed to Demodulate an AM carrier?**
   _____, _____.
7. **What type of coupling is used in the RF & IF section of the Super-Het-Receiver discussed in this lesson? _____**
8. **T6 Secondary in the audio amplifier is center tapped to provide 2 signals that are the _____ in amplitude and the _____ in polarity.**
9. **What is the purpose of Q5 Driver Amp in PC 402 _____**
10. **What is the frequency range of a standard AM broadcast receiver? _____**
11. **Frequency conversion can handled by two stages, or only one. What are they called? _____ , _____ .**
12. **After a receiver is properly aligned, it should have maximum _____ & _____**
13. **What is the frequency of the Local Osc, [LO] ? _____**
14. **What is the main use of the Audio output Transformer [T7] ?**
    _____ _____
15. **What section of a super heterodyne receiver provides the most gain? _____**
16. **Where & what is the first test in troubleshooting an inoperative receiver ? _____ , _____ _____**

TIII: SUPERHETERODYNE RECEIVER

Review Questions;

17. When troubleshooting the superhet receiver, which section [card] do you check first? _____ _____

18. What is the purpose of Cr1 [D1] ? _____

19. When aligning the super heterodyne receiver , Which section is aligned first ? _____ ___ _____

20. What method of troubleshooting is used on the super heterodyne receiver ? _____ _____; _____ _____ _____ .

21. There are four frequencies produced by heterodyning. What frequency is used by the super heterodyne receiver ?

PE Write Up; Example 1.

Card	TP	Indication	Test Equip
39	TP 15		F-Gen
39	TP 9		F-Gen
38	TP 2		F-Gen
38	TP 3	11.89 VDC	DMM
38 DMM	TP 2	280mVDC	
38 DMM	TP 4	280mVDC	
38	TP 2/4	0/0 Ω	DMM

Card: 38
Circuit: LO
Component: Q1
Malfunction: Short

TIII: SUPERHETERODYNE RECEIVER

PE Write Up; Example 2.

Card	TP	Indication	Test Equip
39	TP 15		F-Gen
39	TP 9		F-Gen
39	TP 12		F-Gen
39	TP 10	12 VDC	DMM
39	TP 9	780mVDC	DMM
39	TP 11	220mVDC	DMM
39	TP 10/9	Hi/Hi Ω	DMM

PE Set Up;

Card: 39
Circuit: 1st IF AMP
Component: Q2
Malfunction: Open

1. PC 38 in PC1 position.
2. PC 39 in PC2 position.
3. PC 40 in PC3 position.
4. Set Trainer to 12 VDC, Turn on DC PWR to PC 1,2,3. Turn on Speaker.
5. Attach O-Scope Probe to top of C1a for an antenna.
6. Adjust C1 PC38 for a Radio station. Adjust R12 [39 card] for low volume.
7. Set Function Generator for; 1 KHz, Sine-wave, Use a Test lead as an Injection Device. Run from 600Ω Output.
8. Get Normal DCV.
9. SHOOT & Record Bugs.

NOTE:
Set Test /Operate switch as indicated for optimum bug indications.

F 112/ T	F 202/ O	F 307/ T
F 105/ T	F 212/ O	F 306/ T
F 109/ T	F 205/ O	F 313/ T/O
F 101/ T	F 310/ O	F 309/ T
		F 312/ O